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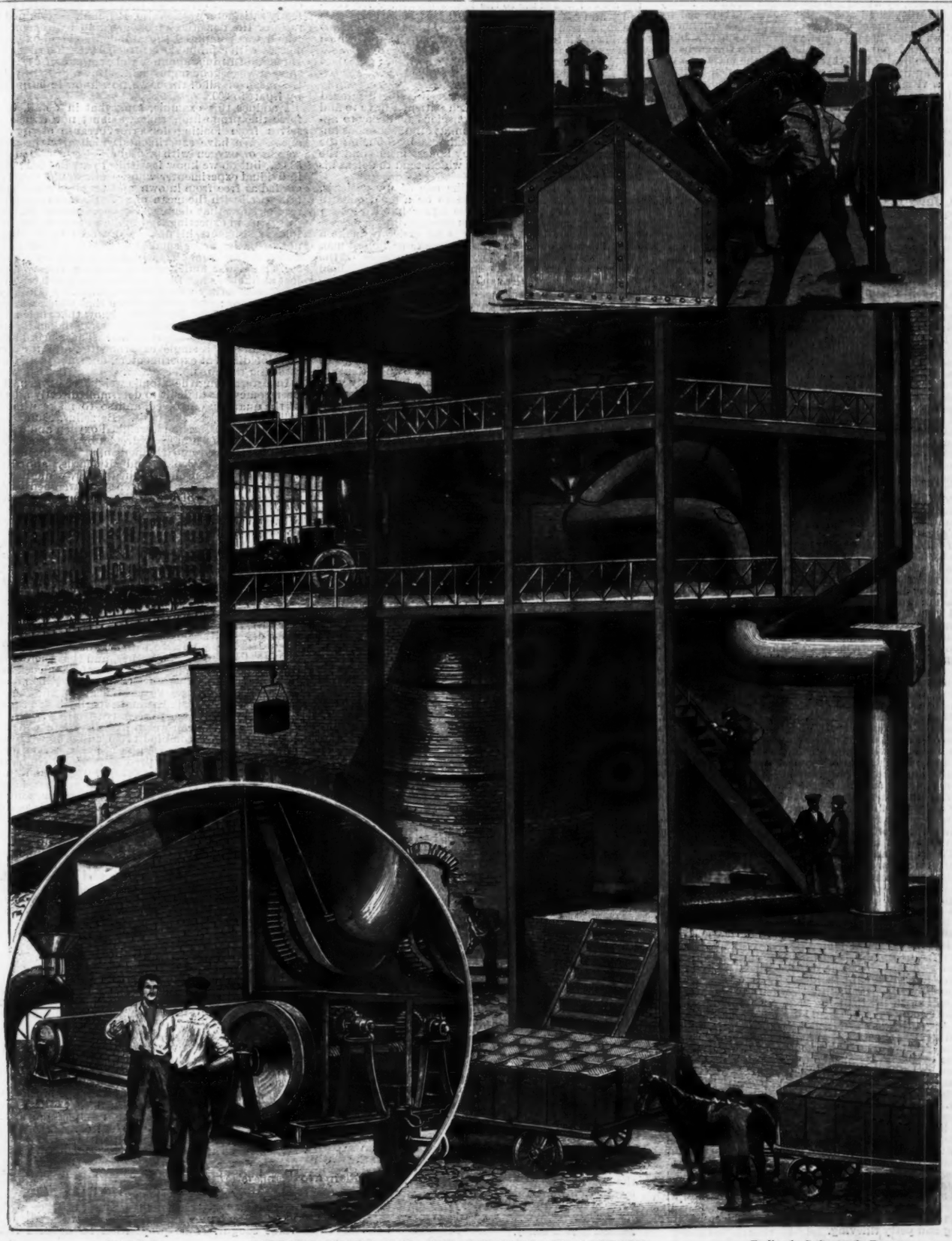


Rotary Drums. BERLIN'S PLANT FOR THE BURNING OF GARBAGE. Feeding the Garbage to the Furnace.

BERLIN'S PLANT FOR THE BURNING OF GARBAGE.

IN all large cities, enormous quantities of ashes and garbage accumulate daily, which must be disposed of in some way. In Berlin, says Das Buch für Alle, this refuse was carted without the city or used to fill up hollow, swampy land, until it was finally recognized that these garbage-heaps might become veritable hotbeds for disease germs. The suburban inhabitants of the city protested against the dumping of garbage before their very doors, as it were; and Berlin was compelled to seek other means of disposing of its refuse. Following the example of those English cities that had begun to burn their garbage, Berlin erected an incinerating plant on the banks of the Spree. The furnace in which the refuse is cremated is composed of iron and fire-brick. The garbage is carried to the plant either by boat or cart, in tightly-closed iron boxes, each having a volume of 18 cubic feet, and is raised by electric elevators to the third and top story, then to be dumped into hoppers, by which it is discharged into huge rotary drums in the second story. The garbage is forced by the drums into the upper part of the furnace and burnt, coal dust being used as fuel. Simultaneously a blast of hot air and coal dust is discharged into the garbage, the intense heat (1,500° C.) converting the mass into vapor and liquid. This volatilized and liquefied garbage forms a vitreous, liquid mass, which, when allowed to drip into water, congeals and forms a substance which is afterward sold at a fair price, thus somewhat reducing the cost of running the plant. The new method of disposing of the city's garbage, from a sanitary point of view, is so far in advance of the old method, that it is to be hoped other cities will establish similar plants.

HYPNOTISM IN PRACTICE.

DR. JOHN D. QUACKENBOS, of Columbia University, has long been engaged in researches and experiments in using hypnotic suggestion for the correction of moral infirmities and defects. Dr. Quackenbos is a pioneer in this kind of work, says The New York Evening Post, for while hypotism has been much used in the treatment of physical diseases, its value as a means of strengthening a weak will and reinforcing the moral sense has been little considered. Dr. Quackenbos gives the following interesting account of his methods and some of the results he has obtained:

"My instruments for inducing the hypnotic state," said Dr. Quackenbos, "are very simple—as simple as this," and with a smile he drew from his pocket a heavy old-fashioned pencil-holder of pale gold, bearing at one end a seal of red carnelian. "I place my patient on a couch, and have him look steadily at this red carnelian, which is placed two or three inches in front of his eyes, and enough above so that he has to strain his eyes upward to see it. Now these are the results: The eyes have to be 'crossed,' as the saying is, because the carnelian is so near; this crossing, and the effort of keeping the eyes turned upward, brings a severe strain on the adjusting muscles. The red color of the carnelian is also irritating to the retina, and these two sources of fatigue, muscular and nervous, finally overcome the patient; his eyelids gradually close, and he drops into a lethargic state, like a heavy sleep. Along with this strain upon the eyes I use a gentle stroking of the patient's limbs, which is an almost indispensable aid to the other influence. The stroking leads to the unconscious state by a soothing of the peripheral nerves—just the opposite effect from that used on the eyes, where extreme irritation leads to overpowering fatigue. Lately I have partly discarded my carnelian for a diamond." Here the doctor produced from his pocket a diamond ring, the band wound with black silk. "I hang this before the patient's eyes," he continued, "so that it moves slightly by the twist of the thread. It is very brilliant, besides having in its flashes a more brilliant red than the carnelian, and it is much the harder thing to look at. The time required to hypnotize a patient varies from three or four minutes in children to over an hour with some adults. Of course all my work is with patients who wish to enter the hypnotic state, but some temperaments are very resistant. One of my patients, a man, looked at that diamond for an hour and a quarter before he gave out. When the patient is hypnotized, the conditions are somewhat like this. He has no memory, in the first place. In fact, when a patient awakes, he usually thinks he has just failed of falling asleep. This was amusingly shown by the newsboys with whom I experimented last spring. When each one of them, after a sleep of fifteen or twenty minutes, was waked, and went out to his companions, he always said, 'Aw! he didn't do nothin' to me. I wuz just fallin' asleep when he waked me up.'

"The important part of the condition is that we have in this state cleared away the patient's objective mind, and by that I mean that we have got rid of the influence for the time being of his conscious mind—the ideas which he has of his own character, his sense of his own likes and dislikes, purposes and appetites. In other words, we have taken away from his mind all the traits which he and others see in him ordinarily, and have left his fundamental mind—you may almost say his character, or innate disposition—stripped of the modifications of the conscious mind. When he is in this state, the 'sublimal' mind, as it is called, can be affected by suggestion; that is, when the operator says to a patient in the hypnotic state, 'To-morrow you will smoke two pipes of tobacco, at noon and night, and if you try a third it will make you sick,' the sublimal mind receives the statement unconsciously, and acquires a strong tendency to do just as the operator directs. It is like getting at the native impulses of a man's disposition, and adding a new impulse which his conscious mind after he awakes cannot recognize as artificial, but accepts as one accepts his liking for a particular kind of food. As to this particular suggestion about tobacco, I know it to be effective. One of my patients whom I had limited to two cigarettes a day was made sick on trying a third. Suggestion is always in the form of a positive assertion by the operator, for the sublimal mind is incapable of reasoning; logic, you know, is conscious. But while suggestion employs no argument, its statements have in one way the quality of argument; and to explain that I must describe my method with petients who are to be treated for moral defects like kleptomania, the drink habit, and in children habits of lying and petty thieving.

"Before treating a patient, I find out all I can about the exact extent of his weakness; especially in the drink habit the exact amount of liquor he uses. I find out his habits of life, his ambitions, all I can about his disposition. Then, when I come to suggestion, say in a case of the drink habit, I say to him: 'To-morrow you will drink two cocktails, at morning and noon. You know that if you get unsteady, you can't do your engraving decently. You will lose your position and bring disgrace on your wife and family.' A little girl whom I treated for a habit of petty lying told lies in order to attract attention, so that in her desire for attention and approval was the trait to which I had to appeal. So, in my suggestion, I told her that her lies caused people to avoid and dislike her; that she must be absolutely truthful, and that then people would like her. In this case the treatment was a complete success. The suggestion, of course, repeated, gave an impulse to truth-telling which the conscious child obeyed, under the force of the same desire for notice which had induced her lying. In the case of the drinking man I mentioned, the appeal was made to the man's desire for respectability and his affection for his family. In every case the suggestion depends for its moral success upon attaching itself to the highest native impulses of which the waking man is conscious. If a young athlete smokes incessantly, he is told that he will fail if he does not stop smoking. A little girl thief, who was extremely fond of her Sunday-school, was successfully influenced by telling her that her thieving disgraced her and offended God. For each patient I have to find some ambition, some strong conscious tendency to appeal to, and then my suggestion, as an unconscious impulse, controls the moral weakness by inducing the patient to further his desires by honest means and the cutting off of immoral habits, which tend to defeat his ambitions.

"Of course, if a man has, like one of my patients, no ambition in the world save to be a good billiard-player, he can't be cured of the liquor habit, because his highest ambition takes him straight into danger.

"It is a curious fact that it is far easier to make a thief into an honest man than to make an honest man steal. That illustrates finely the dependence of the whole treatment on the existence in the sublimal mind of moral impulses. Suggestion depends for success on rousing the moral impulses to greater strength, and so when suggestion opposes the moral impulse, it is nearly sure to fail. My own experience has given me full proof of this, and the fact is important as a safeguard against the criminal use of suggestion. My investigations are far from complete, for I am learning new things every day. But I have gone far enough and have had enough success with my own patients to demonstrate that hypnotic suggestion has a very wide field of usefulness. While there are many successes to be obtained with adults, the best are to be found with children, who are more impressionable, and whose moral obliquities are less firmly fixed by the indulgence of years. With them the power of suggestion amounts almost to a regeneration. The subject, too, has extremely interesting connections with the religious sense."

ARE FURTHER EXPERIMENTS NEEDED FOR DETERMINING THE ATOMIC WEIGHT OF OXYGEN?*

By EDWARD W. MORLEY.

THE precision of experiments on the atomic weight of oxygen has been gradually so much increased that, in some cases, the mean error of a single determination is less than 1 part in 10,000. The agreement of different series of experiments is not so good, but if the work of different experimenters agreed well, the question, how accurately do we really know the atomic weight of oxygen, is not one which we can readily answer. Neither the concordance of the experiments of a given series, nor the agreement of the results of series of experiments by different observers, can excuse us from search for sources of error. All sciences which have to do with measurement afford sufficient instances of the fact that our conclusions are to be received with a certain suspense of judgment. And chemistry well illustrates that he is wise whose assertions regard the possibility of finding at some time evidence to the contrary.

The history of experiment on the atomic weight of oxygen affords an interesting example of the fact that neither the concordance of individual observations nor the agreement of different experimenters proves that a measurement is right. Toward the middle of the century, Dumas made his classic experiments on the composition of water. The probable error of a single experiment was, in round numbers, 1 part in 400, so that the probable error of the average of the nineteen famous experiments was 1 part in 2,250. Now, this means that his final value was not likely to differ more than a certain small quantity from the result of the repetition of even a very large number of experiments made in the same way, with the same skill and care. But as to the difference between this result of the nineteen experiments and the unknown true value, we are told absolutely nothing by the proposition that the probable error of Dumas' result was 1 part in 2,250. It is a commonplace to say that the calculation of the probable error of a series of experiments does not show how nearly the result approaches the truth, but how near it is to the result of a greater number of similar experiments. It decides, not how nearly we approach the desired goal, but whether it is useful to persevere by the present method of approach. Dumas made nineteen observations, and got the value 15·96, with a probable error of 0·007; that is, if he had made 100 or 1,000 experiments, it is unlikely that the final result would not have been between 15·95 and 15·97, and very unlikely indeed that it would not have been between 15·94 and 15·98. But he would never have obtained a value near that which now commands confidence.

It is interesting to recall that there is hardly any instance on record where the judgment of an experimenter as to the degree of approximation to the truth attained in his work has been better justified than in the case of Dumas' classic experiments. As we all remember, toward the end of his work, there was discovered in his own laboratory a source of error, not easy to eliminate, which had affected all his determinations. The amount of the error was not a fixed quantity, and no numerical correction could be applied to the results of observation. Dumas accordingly gave to the public the uncorrected and unmodified results of experiment. But he also stated his opinion as to the degree in which his results approximated, not to the mean of a larger number of experiments of the same kind, but to the unknown and unattainable true value. He expressed the hope that his value would be found not more than 1 part in 200 from the result of those subsequent experiments which should be thought satisfactory; and it is by just 1 part in 200 that his value differs from that which is now accepted.

So the concordance of Dumas' experiments did not prove that his result was right; neither did the agreement of experiments by different observers. Erdmann and Marchand made eight experiments by a method like that of Dumas, with some modifications. Their result was 15·973, with a probable error of 0·011. This value differs from that of Dumas by less than the sum of the probable errors, so that that agreement is perfectly satisfactory. So, also, Regnault determined the ratio of the densities of oxygen and hydrogen, from which was computed the atomic weight of oxygen as 15·963, with a probable error of 0·004. The results of Dumas, of Erdmann and Marchand, and of Regnault, show a very good agreement. But all of them, and the mean of all of them, we now know to be in error by 1 part in 200.

I adduce this example, somewhat in detail, to enforce the proposition that we must not excuse ourselves from looking for error because observations agree. We have experiments which give the atomic weight of oxygen with a probable error of 1 part in 50,000, but do we know it within 1 part in 1,000? Each individual experimenter whose work would now be regarded as free from known and tangible error, agrees fairly well with the mean of all. For instance, Noyes' results show that degree of concordance which would justify us in expecting that, if he were to make 100 or 1,000 experiments, his final mean would be as likely as not to be larger or smaller by 1 part in 9,500, and his result differs from that which we accept by 1 part in 900. So Cooke and Richards assign a value which is just as likely as not to be within 1 part in 8,000 of the result which they would have obtained by multiplying observations; and it differs from that which we accept by 1 part in 1,500. But do we know that their means, and the means of all published results taken together, are not in error by 1 part in 900? The concordance of the results of a single experimenter, and the agreement of different experimenters, does not justify us in asserting that we do.

In determining the atomic weight of oxygen, it has been somewhat difficult to determine directly all three of the quantities involved, and so to make what Stas called a complete synthesis. Berzelius, Dumas, and Erdmann and Marchand, weighed oxygen and weighed water, thus determining hydrogen by difference. More recently, Dittmar and Henderson, and Leduc used the same method. Cooke and Richards, and Keiser weighed hydrogen and weighed water, while Rayleigh and Noyes weighed hydrogen and weighed oxygen. Any proceeding which weighs hydrogen directly has a great advantage in precision; different determinations in a given series agree better among themselves, and the series of different experimenters also agree better. But there is also a second, more important advantage. We have reason to believe that the constant errors involved in weighing hydrogen are small, for it is possible to obtain hydrogen with less than $\frac{1}{10000}$ or even $\frac{1}{100000}$ of its weight of impurity. There is no difficulty in weighing oxygen or water with accuracy, so if we weigh hydrogen and also weigh either oxygen or water, we may hope for a near approximation to the true value of the ratio sought.

We may hope, but we cannot know. We may believe that our hydrogen is pure, and that there was no error through leakage. But an unsafe stop-cock might make the apparent weight of the hydrogen in a series of experiments seem always smaller than the fact, and might yet leave the individual experiments so concordant with each other as to seem trustworthy.

If, however, we can weigh hydrogen and can weigh oxygen, and then combine them and weigh the water produced, we can at least give a better reason for our hope, if we find that the product is nearly equal to the sum of the components. The manipulation in this case is costly, and is so difficult, and involves so many minute details, that not many have patience and time sufficient for it, so that no great number of such complete syntheses has been made, and these few were made in conditions but little varied. When such complete syntheses shall have been made by different observers, with those variations of apparatus and method which may seem wise to them, we shall be able to judge of the magnitude of the errors to be feared. If such results are not concordant, we shall have much to learn as to sources of error; but we now see some reason to expect that they will not be discordant. However, even if they are not discordant, we are not to excuse ourselves from further study of sources of error.

Before repeating determinations so troublesome, and before studying unknown sources of errors not yet detected, the experimenter should receive all possible assistance from chemical theory and from criticism. For some that criticism may be most profitable which is friendly and sympathetic; but, for the experimenter, the value of the criticism depends on the knowledge and the acuteness of the critic. Dr. Hinrichs published, some five years ago, a criticism of all determinations and computations of atomic weights since Dumas. As is well known, he is a most strenuous and insistent supporter of Prout's hypothesis. Looking hastily through the volume, there was found, toward the end, evidence that its author was one of those who, some thirty years ago, discerned that which, in the hands of Mendeléjeff, became the periodic law. It seemed possible that one who had early seen some indications of this law might, perhaps, also have discerned, even if obscurely, some principle relating to atomic weights. I therefore once spent some time and pains in carefully reading the book, and considered at length those passages which, if any, contained valid criticism of the views which are generally accepted.

Hinrichs believes that the mean of a series of determinations of an atomic weight cannot give the true value sought. This proposition he deduces from a

* President's address, delivered before the New Haven meeting of the American Chemical Society.

mathematical discussion. He believes that as larger and larger quantities are taken in our analytical operations, the results differ regularly from ideal accuracy; sometimes the difference continually increases as the quantity taken increases; sometimes the difference increases to a maximum and then decreases again. The proper computation of an atomic weight then, according to Hinrichs, consists not in taking the mean of different observations, made with different weight of materials, but in determining the limit toward which the series converges as the weight taken decreases. A good illustration is given; we cannot determine the weight of a new coin by weighing any number of old coins; every coin is worn and therefore light, and the mean weight of any number whatever is therefore necessarily below the mean weight of new coins. But if we weigh old coins and note the date of each, we may take the mean weights for each year separately. If we examine coins enough, these means when plotted as the ordinates with the years as the abscissas will give us a "fairly regular curve, lowest for the oldest coins, gradually rising toward a limit which they would not quite reach. This higher limit would evidently be the mean weight of the new coin."

This is an intelligible proposition. It seemed to me worth while to examine it, for to this proposition one of the most enthusiastic and most active supporters of Prout's hypothesis, a man not lacking in shrewdness or ability or learning, has intrusted the defense of his favorite belief.

He asserts that an atomic weight as determined by experiment is variable, that it depends on the amount of substance taken for the analysis or other operation, and that it varies in a continuous and regular manner. His proposition is, that an atomic weight as determined by experiment is a function of the weight of substance taken. Is there any evidence in favor of it?

I answer, first: Theory does not afford any evidence for it. Hinrichs deduces this proposition from theory by a discussion which is mathematical in form. Whether the proof is sound need not be considered, for his theory does not attempt to show the order of magnitude of the regular and continuous variations which are affirmed to depend on the weight of substance taken, and to show whether they can be separated from the irregular and discontinuous errors due to accident. We are sure that accidental errors exist; we may concede, for argument, that regular and continuous variations also exist; but this is far from implying that the actual errors in a given set of experiments will be largely or even perceptibly of the latter kind. Theory shows that there is a diurnal tide in the atmosphere; but theory does not show that the differences noted in a series of ten observations of the barometer at different hours of the day will follow the law of the diurnal tide.

But, secondly: Facts do not agree with the proposition. The accidental errors of the most precise experiments yet made are so much greater than any systematic variations, that nothing but accidental variations can be detected. To prove this, let us consider Stas' synthesis of silver nitrate from pure silver. This is one of the most important determinations ever made; Hinrichs has discussed it twice in his volume; he asserts that the ratio of silver nitrate to silver found in each analysis depends on the weight of silver taken, and twice draws curves to show this. I assert, on the contrary, that the errors, which average only 1 part in 40,000, are purely accidental, and that they follow no law. This can be proved by proving that the ratios obtained depend on any other quantities selected by accident just as much as they depend on the weights of silver taken. Hinrichs plots the results of the ten determinations, using for abscissas the weights of silver taken, and so obtains tolerable curves. I plotted the same ten observations, using for abscissas not the weights of silver taken but ten numbers selected by sortes Virgilianae, and get curves quite as tolerable as before; and this I did with ten different sets of abscissas, all selected by pure accident. Now, quantities which depend on any one of eleven sets of abscissas, ten of which are selected by accident, are themselves accidental in their variations, and the variations follow no law. So far as the facts are examined, they give no evidence in favor of Hinrichs' proposition: we have seen that theory is equally chary of her support, and we may safely dismiss the suspicion that any source of systematic error can be detected in deducing atomic weights from the means of good experiments.

(To be continued.)

STRENGTH OF STEEL BALLS.

THE results of tests made at the Rose Polytechnic Institute upon steel balls were reported by Mr. F. W. Harris at the New York meeting of the American Society of Mechanical Engineers. Balls were procured of sizes ranging from ½ to 1 inch in diameter from six manufacturers, and the attempt was at first made to test the balls by crushing between hardened steel plates. Difficulty was experienced, however, in procuring steel so hard that it would not indent under the pressure to which it was subjected in contact with the balls, and the plan was adopted of placing three balls in a row in a special holder, which kept them in line axially. Pressure was then brought to bear upon the two outer balls, eventually crushing the middle one. After this series of tests was completed a steel was found that answered the purpose for testing the balls between flat surfaces and another line of tests was conducted with the balls between two flat plates of this steel. A singular fact is that in the first series nearly all the balls were broken by the formation within the ball of a conical wedge which was gradually forced toward the center of the ball until the latter was split. The base of the cone was approximately circular, with its center at the point at which the crushing force acted. The following table gives average results of the two series of tests. It will be seen that the values in the last horizontal row are higher than in the second row, showing that the balls withstood more when tested between flat plates than when they had the point contact, simply, of the first test:

BREAKING PRESSURE IN POUNDS.

Diameters.	Strength.					
	½	¾	⅞	¼	⅞	1
Between two balls	2,000	4,000	8,000	15,000	22,000	60,000
Between flat plates	3,000	5,000	12,000	20,000	32,000	90,000

VARIABLE SPEED GEAR.

THE hunt for a good variable speed gear for motor carriages has led to the invention of many ingenious devices, some simple, some complicated, some good, many bad. We have been recently requested to see one in operation which has at any rate the merit of simplicity. Time alone can show if it will be of practical utility. We have the assurance of the inventor that the wear of the parts is not excessive, but as the mechanism depends for its action on a reciprocating and intermittent motion, only a prolonged trial under working conditions can prove that it is sufficiently strong and durable to work for long periods without repair. The general appearance of an experimental gear is shown by Fig. 1. The shaft is not continuous; one end of it is driven at a constant speed, and the

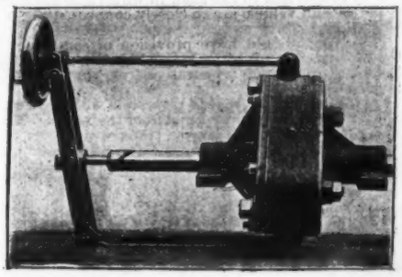


FIG. 1.—NEWMAN'S VARIABLE SPEED GEAR.

other runs at various speeds within the limits of the mechanism. Its rate is regulated by the hand wheel and screw. The internal gear is shown in Fig. 2. It consists of a spur wheel keyed or cut on the extremity of the variable speed shaft, placed centrally in the case. Three wheels mesh with this pinion. Each of these wheels is driven by a roller clutch similar to those now largely used in free-wheel bicycles. A crank pin is fixed as shown in the disk of each clutch. A plate (Fig. 3) carries three limbs, through each of which is a hole into which one of the crank pins is carefully fitted. Inside this plate is an eccentric, of which the throw can be varied by means of a pin working in the spiral slot shown in Fig. 1. The eccentric, it will be observed, is fitted with ball bearings; it is driven by the constant speed shaft and its motion is

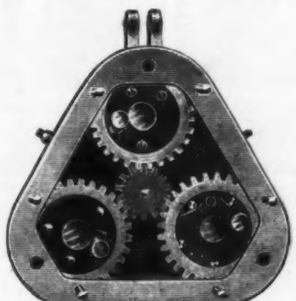


FIG. 2.—VARIABLE SPEED GEAR.

transferred to the three-clutch, which it causes to reciprocate more or less as its throw increases or diminishes. When the throw is small, the corresponding partial rotation of the clutch wheel is small, and in consequence the rotation of the variable speed shaft is also small, and vice versa. It must be observed—and the point is of considerable importance—that on account of the arrangement the clutches drive in rotation and that the next one is in before the previous one is out. Were it not for this the blow on the rollers with a heavy load would certainly destroy the mechanism in a short time unless it was made excessively heavy. As it is, no appreciable knock occurs when the gear is running at its highest speed, and if continued use shows that there is not excessive wear of the parts, there should be no trouble in that direction.

FIG. 3.—ECCENTRIC PLATE.

At present the work that Mr. W. H. Newman, of Totteridge Park, Herts, the inventor, is engaged upon, is some means of balancing the eccentric. This is very essential, as in the existing design the vibration at high speed is very apparent. The problem is not an easy one, but Mr. Newman thinks that he will succeed in solving it without great difficulty, and he is, we believe, already engaged on the construction of a new experimental apparatus which shall be free from vibration. Whether the eccentric alone is the cause of vibration remains yet to be seen. It may be found that the action of the clutches coming into gear gives a jerk to the mechanism in spite of the manner in which they are arranged. It should, by the way, be pointed out that the whole mechanism is entirely inclosed and works in a bath of oil.—Engineer.

GASOLINE MOTORS FOR AUTOMOBILES.

By GEORGE KELLOGG BARRETT.

AS many manufacturers as there are of stationary gas and gasoline engines, it seems strange that but few or none of them have turned their attention to the making of gasoline engines suitable for use in automobiles. Doubtless the case would be different if it were known what a ready sale awaits any thoroughly practical motor and if the objects necessary of accomplishment were understood.

As to the former, there is no maker of automobiles who has anything practical to offer who is not flooded with orders. No deliveries are promised within three months of the placing of orders. To add to the stringency, the inability to secure the vulcanite cells for the accumulators of electric vehicles makes those vehicles less active competitors of the gasoline rigs than would otherwise be the case, although the electric is surrounded by so many restrictions in the way of limited area of travel that it is not a really dangerous competitor, except for strictly city use, and even in cities a well constructed gasoline vehicle answers all purposes.

Steam-driven autos are a factor in this country greater than they are beyond the Atlantic, but the objections which apply to the electric also apply—in a much more restricted degree, however—to the steam vehicle. In France, the home of the automobile, steam and electricity are little known for private traction purposes. In England the same condition prevails. At a recent exhibition in London, there were shown but one electric and one steam vehicle, the latter an American one, out of a total of 100 exhibited. While this does not prove that gasoline is to furnish the exclusive motive power of the future, or even the greatest percentage of vehicles, it does prove that it is practical and capable of being made the basis of a lucrative business by many concerns.

That there are so few automobiles seen in America is not due to any lack of demand but to a scarcity of practical vehicles. This scarcity, again, is not due to any lack of capable men working to supply the demand, but to the shortness of the time during which they have been at work, and, no doubt, in many cases, a lack of knowledge concerning the basic principles of the motors on which they are working. Particularly is this noticeable in regard to gasoline motors.

There are numerous difficulties in the way of constructing automobiles, especially steam and gasoline, and the constructor has other problems, quite as difficult of solution, in the building of a thoroughly practical motor. If the constructor were able to buy his motor in an approximately perfect state and then devote his attention to elucidating the other problems, he would be working to far greater advantage. In fact, the other problems are far nearer solution than the one of building a thoroughly practical gasoline engine for this particular work.

Now, those men who are engaged in the manufacture of gas and gasoline engines on a commercial scale, with all the facilities of well equipped shops, with no other problem to divert them from the building of practical motors, and—not the least important advantage—with an intimate acquaintance with the idiosyncrasies of gasoline engines in general, should be able to arrive at the solutions of the problem—there are more than one—in a more rapid and a more economical manner than those who have not these advantages. The only thing necessary is to start with a knowledge of the requirements of gasoline motors as applied to traction purposes. It is the object of this article to outline briefly these requirements.

An engine for a vehicle designed to carry two to four persons should develop at least from four to six horse power, to make it practical under all conditions. Engines of this power will be most in demand for some time to come, if not permanently. Larger sizes will be needed for omnibuses and freight vehicles as well as a few of the more elaborate private conveyances, but the present demand in America is for a motor adapted to private passenger vehicles. Engines of smaller power are suitable for motorcycles—the generic term for two, three, and four-wheeled conveyances built on the lines popularized by cycle building.

Both horizontal and perpendicular engines are used successfully abroad.

Naturally the ideal engine should be economical, but for private traction purposes this is a consideration of minor importance, as the cost of travel is, at the greatest, comparatively small. Other features are more important.

One of them is the desirability of a long period of service without the necessity of replenishing the fuel, which, however, involves the question of fuel economy.

The desirability of compactness is so apparent that it seems almost needless to mention it.

Another equally apparent desideratum is light weight, which involves and is inter-dependent upon other desirable features, like constant torque, the absence of large flywheels, the use of multiple cylinders and some provision for cooling without complicated and heavy devices for water circulation. Finally, the engine should provide an exhaust that is as nearly noiseless and odorless as possible.

Taking up the question of weight, there can be set no definite bounds beyond which it is not safe to transgress, as other desirable features might well counterbalance a little weight in excess of what an expert would set down as the maximum allowance. Gasoline motor-vehicles to accommodate two persons have been built as light as 450 pounds. While such light weight is not necessary, it is certainly desirable, for more reasons than one, the most important of which is the many stresses put on the wheels. In a vehicle of this weight, not more than 150 pounds can be devoted to the motor, carbureter, fuel tank and cooling devices. If water cooling is used, it will be seen that there must be light and efficient devices for reducing the temperature of the water after it has reduced the temperature of the cylinder or cylinders, or else the amount of water that must be carried will be too great.

In a one-cylinder engine the weight of the flywheel necessary to maintain anything like constant torque would be too great. Therefore it is desirable to have

more than one cylinder, if for this reason alone. Two have been used successfully; three seem, at present, to be the most practical in actual service; while four, and even a greater number, have been tried with results that have been claimed to be excellent. The use of a multiple number of cylinders makes it easier to provide sufficient cooling without the use of water. It is possible to construct a multiple-cylinder engine in which the flywheel will be an unimportant feature. Of course the construction of such an engine involves expense, but expense will not prevent the general use of a successful engine.

The necessity for eliminating vibration and maintaining lightness is another very cogent reason for using more than one cylinder. Involving several other problems, is the one of constructing an engine that will work well under loads of varying amount and frequent change. Whether this can best be done by running the engine at an approximately constant speed, leaving the matter of the transmission of that speed to the vehicle constructor, or by varying the speed of the engine itself, is a question that is best left to the experimenter to solve. Either expedient will serve. It would seem almost necessary, however, to adjust either the quality or the quantity of the explosive charge in proportion to the amount of work to be done—automatically, of course. Both quality and quantity may be changed, but to keep the quality constant and vary the quantity appears to offer the best results as applied to automobiles. The hit-and-miss plan is not feasible.

In this connection, it may be well to say that there appears to be opportunity for great improvements in the way of introducing a measured quantity of liquid gasoline into a measured quantity of air and of having little more than enough of the explosive mixture on hand at any one time than is necessary for the charging of the cylinder at the next inspiration.

Taking up the question of eliminating vibration, that may be accomplished in a number of different ways which will suggest themselves to the experimenter. The use of two opposed cylinders with a flywheel of moderate weight has been found satisfactory. The result, however, can doubtless be better accomplished by the use of three or four cylinders, set in any manner that is found most convenient. It will be well to construct the driving shaft to run parallel to the axles of the vehicle, to do away with the use of bevel gears in transmission.

One highly important consideration is the proper cooling of the engine without the addition of weight of any great amount. This includes the use of little water, if water be used at all. Where water is used, the French, who have arrived at the greatest degree of advancement in the building of gasoline automobiles, utilize water-cooling tubes provided with fins for radiation, the whole arranged in coils. The copper tubes are provided with very thin fins of iron or aluminium, according to the requirements of weight and economy.

The motors of small horse-power or numerous cylinders, however, are provided with no means of cooling other than thin fins for radiation on the outside the cylinder. Exception may be made in the case of one Frenchman who provided, within the piston, itself, a cooling device, by the aid of simple auxiliary mechanism. It is possible to construct a six horse-power, three-cylinder gasoline engine that will need no cooling device not integral with the cylinders themselves.

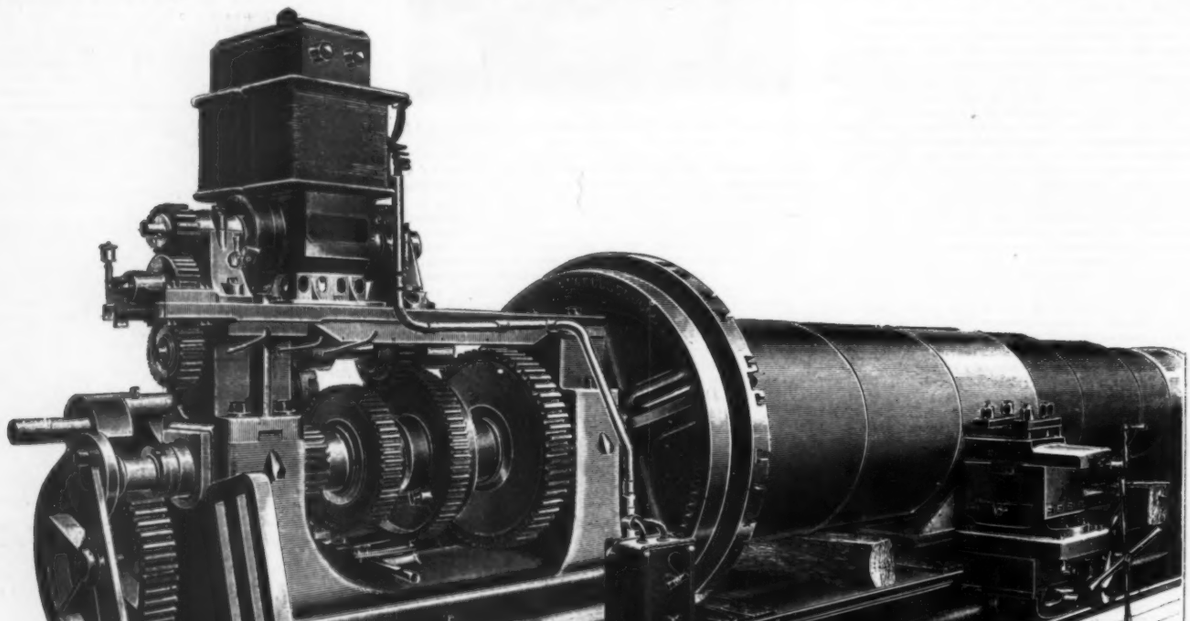
The actual speed of the engine itself need cut little figure, as the speed of the vehicle to which it is attached will be regulated in the transmission, unless an attempt be made to regulate the speed of the engine in proportion to the load, in which case the speeds of engine and vehicle are so closely connected as to be inseparable.

The engine should have provision of some sort for starting itself or of being started by the use of light manual power which is operative from the seat of the vehicle.

Finally, an engine that is reversible will prove valuable, as it will relieve the builder of the vehicle of the problem of providing a reverse transmission.

If the features outlined in the foregoing can be accomplished with the use of kerosene instead of gasoline, the results will be still more satisfactory.

That it is a difficult task to accomplish all these results is a foregone conclusion, but that it is a task too difficult for American inventive genius, the writer will not admit. We already have the results accomplished by the French and Germans in this line to help us, and it would be an insult to American ingenuity to admit for a moment that we can not excel the foreign designers, once we set ourselves to do so. It is no task to be accomplished in a day, but, when it is accomplished, the financial results will be more than sufficient to pay for long and studious work.—Modern Machinery.



ELECTRICALLY-DRIVEN SHAFT LATHE.

A BIG SHAFT LATHE.

THE lathe illustrated herewith was recently made by Messrs. Beyer, Peacock & Company, Manchester, for Messrs. Vickers, Sons & Maxim's works at Sheffield. It has driving headstocks and face-plates at both ends. The latter are 6 feet 3¼ inches in diameter, and the bed is 90 feet long, giving a clear length of 75 feet 6 inches between the main centers. It was specially designed for heavy work, such as guns, propeller-shafts, and the like, and is fitted with the necessary appliances for sliding, surfacing, and screw-cutting. The jaw chucks can take work 5 feet 7½ inches in diameter. It is provided with two "following" head stocks, so that it can be used as two independent lathes, each taking work 30 feet 6 inches long between the centers, each half of the bed being fitted with two saddles and four compound slide rests, while all four saddles can be worked in conjunction when required. The driving headstocks have quadruple gearing, and are driven by variable speed motors. The latter were applied by Messrs. Vickers, Sons & Maxim, after the lathe was in position, all provision for them having been made by Messrs. Beyer, Peacock & Company, in designing the lathe. The main spindles, which are of steel, are 12 inches in diameter, fitted with collar bearings to take the end pressure. The guide screws are each fitted with a clutch arrangement, to enable them to be disengaged from the spindle driving gear, and driven, if desired, by an electric motor, for quickly moving the heavy rests and saddles from one part of the bed to another. The bevel wheel seen at the lower end of the larger worm wheel shaft was provided to enable a motor to be applied when required. Ratchets for giving feed motion are provided to actuate the saddles and rests independently of the guide screw. The lathe is further provided with roller brackets for carrying long and heavy work. The total weight of the lathe is 100 tons.

On account of the great length of the lathe, it was found impossible to get a satisfactory photograph of more than a portion showing one rest. The other rest and headstock are precisely similar to those shown.

We may add that tests made by Messrs. Vickers to ascertain the E. H. P. expended in driving one of the headstocks under the conditions named below gave the following results: *a*. Running "light" with a 23-ton forging, slowest lathe gear and fastest motor gear, 450 revolutions, 0·6 horse power. *b*. Boring a gun carriage, weight 2½ tons, cut ⅜ inch, by 0·5 inch feed, 1·2 horse power. *c*. Same piece of work, parting cut 2¼ inches wide, by 0·04 inch feed, 6·5 horse power. *d*. Rough turning a gun tube, 23 tons weight, four tools roughing, each cut ⅜ inch, by ¼ inch feed, two tools on 29-inch diameter, and two on 19-inch diameter, the lathe gear and speed being the same as in *a*, 10·7 horse power.—The Engineer.

LORD RAYLEIGH ON FLIGHT.

AT a meeting of the Royal Institution, Lord Rayleigh delivered a most interesting discourse on the above subject. He pointed out that the main problem of the flying machine was the problem of the aeroplane. The action of the wind on the plane could be experimented with up to a certain extent by means of kites, but these kites were always anchored to the ground, and as soon as this anchoring was taken away, the problem becomes much more difficult. Lord Rayleigh proceeded

to analyze the action of birds in flying and sailing without flapping their wings, and pointed out several popular misunderstandings in connection with such named operations. Proceeding to discuss the general question of the action of the wind on an aeroplane, Lord Rayleigh showed one or two experiments. In one of these it was seen that a light piece of sheet brass evenly pivoted in, and nearly filling up, an aperture through which air was issuing under pressure, tended to set itself square to the aperture so as to block it as much as possible, but, if started, it continued to rotate in either direction, emitting a roaring sound. This phenomenon had never been properly explained, nor had the somewhat analogous action of a piece of card which, when dropped, reached the ground with a rotary motion. As to the pressure of the wind on a plane surface, if the latter was falling vertically, at the rate, say, of four miles an hour, and also moving horizontally at, say, 20 miles an hour, did the horizontal motion make a difference to the pressure that existed at its under surface? It might be argued that it did not; but the argument was fallacious, and the truth was that the horizontal motion much increased the pressure under a vertically falling plane, a fact on which depended the possibility of flight, natural and artificial. Lord Rayleigh showed how this point might be illustrated, and even investigated, by means of a simple variation of the ordinary windmill. This was a light wheel having six vanes, each of which could be set at any desired angle, and it was used by setting four at a particular angle and finding at what angle the other two must be placed so as to compensate the rotation of the wheel produced by the former when it was moved quickly through the air. He next observed that not only was there pressure underneath a bird's wing or an aeroplane, but that the suction above was not an unimportant matter, and he performed an experiment to show the reality of this suction, about which he said there had been some skepticism. Turning to flight on a large scale, he remarked that it was a natural question to ask, Was it possible for a man to raise himself from the ground by working a screw with his own muscular power only? The investigation was not difficult, and the answer was that it was quite impracticable for him to do so. Artificial flight was a question of the speed of the horizontal motion. A bird did not use a revolving mechanism like a screw to propel itself, but he had no doubt that a revolving mechanism was the most suitable for artificial flying machines. Whether the difficulties of these would be surmounted he did not know, but he was disposed to agree with Mr. Maxim that it was mainly a question of some time and much money. Still, he did not think flight would ever be a safe mode of conveyance for those who were desirous of going out for a day's shopping, for it was hard to see how alighting on the ground could ever be rendered quite free from danger. But, as Mr. Maxim once remarked, the first use of flying machines would be for military purposes, and they had not yet succeeded in making war quite safe.

SOLIGNAC'S ELECTRIC FORE-CARRIAGE.

IT appears that electric automobilism has a tendency toward using the motive fore-carriage or front hauler. In fact, in addition to the Heilmann fore-carriage, which is rather a four-wheeled electric hauler, we now have an electric fore-carriage, the invention of M. Solignac.

This apparatus, which has recently been presented to the Société des Voitures Electriques, of Paris, exhibits certain interesting peculiarities.

To begin with, it well realizes the idea of a genuine motive fore-carriage in that it is capable of being adapted to any kind of vehicle by fixing it to the seat through the use of the same apertures as those that hold the bolster pin frame of horse-drawn carriages. A person owning but a single carriage can therefore make use either of his horses or of his electric front-hauler.

The arrangement consists of a horizontal frame divided into three compartments—one of them central and containing the box of accumulators, and the two others lateral and inclosing the wheels and electric motors, as well as two Bovit electric brakes. The motors are connected in series, and each controls a wheel. They are suspended independently. The frame as a whole and the parts that it contains are attached by carriage springs to an iron plate support, on which is a ball-raceway of large diameter. A plate bolted to the floor of the carriage has a similar raceway to receive the balls of the pivotal steering bearing. Upon this plate is placed a steering hand-wheel that acts upon the fore-carriage. The wheels have a tendency to turn under the influence of the slightest steering stress; and despite the relatively great weight of the fore-carriage, which is 1,650 pounds including the 1,100 pounds of accumulators, it may be turned either way very easily.

Another original feature of this carriage is that it has no accessories for regulating the speed. The variations in speed are obtained by cutting off or admitting with full force the current supplied to the motors. The vehicle is thus driven by series of impulses, which give it a mean speed. If the current is admitted at frequent intervals or kept on any length of time, the speed increases; but, if it is admitted infrequently, the speed is reduced. Upon the whole, the running is somewhat like that adopted in practice by the motormen of mechanical street cars, who, in order to control the speed in dangerous places, proceed by fits and starts. This arrangement appears to us to be interesting, in that it operates very well without inconveniencing the passengers, and as it suppresses one of the principal causes of the complication of electric carriages.

The breaking and admission of the current are effected through a handwheel concentric with the steering one and situated beneath, as may be seen in Fig. 2. When the driver grasps the two handwheels tightly, they approach each other and a current is let into the motors; but when he relaxes his hands, the lever hand-wheel descends, and the current is broken. The accessory parts as a whole are arranged under the floor of the seat.

By reason of the low position of the accumulators, the center of gravity is also very low, and this gives great stability to the entire carriage. Moreover, the passengers are not affected by the shocks that the mass of the accumulators involves. The accumulators, moreover, are suspended in the frame by springs and upon a double floor resting upon twenty rubber balls that totally deaden the jarring.

Upon the whole, the entire arrangement affords a very elegant carriage, which does not cause much regret for the absence of horses. Finally, such a solution of the question will tend to extend electric automobilism, since for a sum four times less than that needed to purchase a complete electric carriage, it offers the public a means of adopting this mode of locomotion. This method of propulsion seems to be very applicable to fancy carriages in cases in which the owners have at their disposal a complete electric installation that permits of using a charging current at will.

For the above particulars and the illustrations, we are indebted to La Nature.

FIG. 1.—GENERAL VIEW OF THE CARRIAGE.

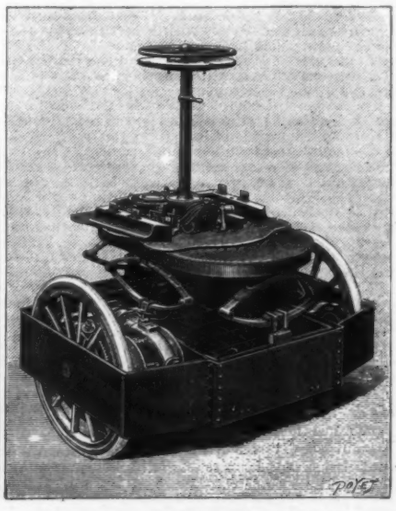


FIG. 2.—DETAILS OF THE FORE-CARRIAGE.

ELECTRO-MAGNETIC SEPARATOR.

WE illustrate herewith a patent electro-magnetic separator for extracting iron and steel particles from borings or other mixtures in which they may be present. In the illustration, for which we are indebted to Industries and Iron, it is shown with its own dynamo, the power required to drive the combination being about 1 horse power actual. The use of electro-magnets in place of permanent magnets enables the magnetic force to be kept constant, and also enables the magnetism to be controlled by a patent knock-off motion. By this means the magnets are demagnetized for a portion of each revolution, and the iron collected is allowed to drop into the receiver, thus leaving the magnets free for a new collection. The difficulty of clearing the magnets, as was always necessary in the case of permanent magnets, is therefore obviated. The improvements thus introduced secure a high output without skilled labor. In the type shown in our illustration the weight of the separator is 390 pounds, the driving pulley is 20 inches diameter for a 2½-inch belt, the space occupied 2 feet 6 inches by 3 feet by 4 feet 6 inches high, the daily output 2 tons, and, as we have said, the power required is one horse power actual.

ELECTRO-MAGNETIC SEPARATOR.

(Continued from SUPPLEMENT, No. 1259, page 20189.)

AN AMERICAN PACIFIC CABLE.*

By GEORGE OWEN SQUIER.

PROPOSED MANAGEMENT OF THE CABLE AS A GOVERNMENT ENTERPRISE.

ASSUMING that the proposed Pacific cable will be established by the Government, opportunity will be presented in this new and unoccupied field of the Pacific, unfettered by precedent and obligations, to introduce such radical changes in the policy and business management of the enterprise as will operate advantageously to the whole people who are directly concerned, and for whom the cable is primarily built. Private corporate management naturally aims at large dividends for its stockholders. It is a matter of statistics that in cabling throughout the long distances involved in the East, out of every one hundred messages sent, ninety-nine are purely commercial in character, and one of private nature. Cabling throughout the world is so expensive that it is only resorted to for urgent commercial purposes. The present tariff rates strictly limit the kind of traffic offered, and prohibit all other than that of the most urgent nature, and are sufficiently high to keep the long cables actually idle for a considerable portion of each twenty-four hours. The enormous volume of the present mails indicates that the world's cable plant could be duplicated many times and all kept full to overflowing if the cable rates were sufficiently reduced.

ELECTRICITY THE IDEAL MEDIUM FOR TRANSMITTING INTELLIGENCE.

The triumphs of science in the last half century have been nowhere more exemplified than in the enormous strides made in the facility of transmitting intelligence. The mails, the telegraph and the telephone are civilizing the world. Perfect as is the mail system of to-day, a monument to organization, yet its swiftest messenger—steam—is so far outstripped either on land or sea by the practically instantaneous electric current, that the tendency year by year is to put more of the world's business "upon the wire." The time is fast approaching, let us hope, when a telegraph and cable letter service at rates comparable with present postage rates will be realized throughout the world, with its consequent revolutions in business and social methods. Time has an international money value. The fastest mail express, or the swiftest ocean mail ship, are as naught compared with the velocity of the electrical impulse which practically annihilates any terrestrial dimension. As the distance increases, electricity surpasses steam in a continuously increasing ratio. In the case of a message to be sent across the street, probably there is no more efficient and satisfactory method

* A paper presented at the 128th Meeting of the American Institute of Electrical Engineers, New York, December 27, 1899.

than by a mail delivery messenger; but if this message is to be sent half way round the earth, the minutes required by the telegraph run into weeks and months by the slow process of the mails. Steam time is directly a function of the distance to be traversed, and from the nature of things must require twice as long to go two miles as one. If then the cable saves six days between Europe and America, it will save more than twice this time between America and the East, and is from this point of view correspondingly important and necessary. Since electricity so far outstrips any other known vehicle for transmitting intelligence, it must eventually carry all the important information and practically take from the present mails more and more of the most urgent letters.

CONTINUOUS USE OF THE CABLE PROPOSED.

With a Pacific cable in operation, and possessing such immeasurable advantages over the mail, how can any management be entertained which does not aim at the use of the cable continuously to its fullest capacity? Cable property is peculiar in that it does not, like mechanical machinery possessing moving parts, deteriorate with use, and its life is not therefore dependent upon the amount of traffic transmitted. The ordinary manufacturing plant is usually not operated continuously because the coal consumption, the wear and tear of machinery, and the extra expense of employes combined with the state of orders received, do not present a sufficiently attractive economical proposition. But a large cable property presents unique conditions from a purely business standpoint. The bulk of the capital invested is buried under the sea, and much the largest item to be earned is the interest on the capital. A 2,000-mile line requires but two operating-stations, and the annual expense of a few clerks, who actually operate the plant, forms a comparatively insignificant part of the total annual expense.

In the estimate of Mr. Alexander Siemens upon the British Pacific cable in a paper at Ottawa in 1894, but 12 per cent. of the total annual expense was for operating staff proper, and this also provided for more than double the usual wages, in consideration of the isolated positions of the mid-ocean stations. Add to this the fact that what ordinarily corresponds to coal consumption here consists of a few electric batteries, and is therefore practically nil, and also the fact that using the plant causes no deterioration, and the logical business conclusion is reached that ocean cables should be kept busy continuously. Every hour they remain idle is so much service absolutely lost. Present cable tariffs are so high as to force to idleness for a considerable portion of each twenty-four hours all of the long cables of the world. In addition the Atlantic cables are practically silent one day in seven.

In defense of the present management, too often unjustly criticised, it is submitted that cable property on the whole has been particularly hazardous and uncertain; repairs often most expensive, and a prudent management has required large sinking funds and reserves. Furthermore, the necessary traffic arrangements required with co-operating or competing companies establish precedents and form obligations not easy to suddenly change. The whole of cable history does not yet cover fifty years, but the skill and experience of the large cable manufacturers in England have brought this industry to such a state of perfection that the laying of a 2,000-mile ocean cable, or its repair, in 3,000 fathoms, is no longer considered a particularly hazardous undertaking. In fact, in the beginning, cable rates had to be high, and although there has been a steady decrease in rates to the present, as the technical side of the business has become more stable and certain, yet it is believed that the time has now arrived when a more extensive classification and reduction can be inaugurated with advantage both to patrons and to revenues earned.

As a practical means for operating the cable continuously, it is a natural suggestion to classify the traffic offered and establish differential rates therefor as is now universally done on land lines. The same causes which have established night rates on land are much more potent in case of ocean telegraphy, where the time gained and the capital invested per mile is enormously greater. It is simply a matter of paying for time. The stock exchange message where minutes are valuable should be charged the highest rate, while the press and less urgent business messages should be classified and paid for according to the time limit called for in delivery. Since the only other competitor in the Pacific is the mail steamships, where the minimum time is over two weeks, it should be easy both to create new business and to draw from the mails as desired. In handling certain classes of messages it can be distinctly agreed to deliver only within a certain number of hours or a week or even establish a low Sunday rate for certain classes of matter, and still arrive much ahead of letters sent by mail. If we have no less than four classes of matter in the present mail system by steam train, why not a classified service for an ocean cable postal system, where the reasons for it are more potent?

For the fiscal year ending June 30, 1898, the amount of mail matter, letters proper, excluding all other forms of mailable material, carried in mail steamers from the United States across the Pacific Ocean for Japan, Hong Kong, Shanghai, Manila, Singapore, Cochin China, Java and Siam was about 10,948,651 grammes, representing about 1,156,176 letters; from the United States for Hawaii 3,495,442 grammes, representing about 369,072 letters. This reveals the appreciable proportion of the Pacific traffic which stops at the Hawaiian Islands, being from the above figures about 25 per cent. of the entire traffic which in 1898 left the United States for these countries. These figures are instructive as indicating that in considering the through trans-Pacific cable, the Hawaiian traffic is not entirely to be ignored, and that of the entire length of the cable, the span between California and Hawaii will continuously be required to carry a materially greater portion, and will, therefore, be the first span requiring duplication.

Assuming as above that the carrying capacity of the proposed cable be equal to that of the best Atlantic cables for corresponding lengths, it is of interest to obtain in a general way the amount of traffic which can be handled across the Pacific under a management which insures the cable being used continuously.

The proposed cable should possess a carrying capacity each way per annum of about 5,900,000 code words of eight letters, and this allows 30 per cent. of the entire amount as waste or non-paying traffic. This means, of the 1,156,176 letters which in 1898 were transmitted to Japan, Hong Kong, Shanghai, Manila, Singapore, Cochin China, Java and Siam, this entire number could have been transmitted by cable, allowing for each communication about five words of eight letters each. Since the use of code books for cable messages has so much increased that practically all cabling is now transmitted in this manner, we can reasonably take one word equivalent to five by their use, so that each communication above referred to is equivalent to twenty-five words of average length.

MEANS FOR DUPLICATION.

All important submarine cables should be duplicated as soon as possible. Cables are always liable to interruption from a variety of causes, and the interruption of a single line necessarily suspends all communication. The protection of the patronage requires duplicate lines if for no other reason.

An adequate plan for a Pacific cable should consider means for the duplication of the line. In this connection an examination of the Pacific Ocean, and the route of the proposed British Pacific cable from Vancouver to Australia, suggests a span of cable of international value. Reference is made to the desirability of connecting Hawaii and Fanning Island with an Anglo-American cable, operated by the governments concerned, under rules mutually acceptable. A common interest should lead to the linking together of these two great ocean telegraphic routes in the mid-Pacific.

With this single span of the cable laid, which is but about 950 nautical miles in length, or but 13 per cent. of the length of either of the main lines, it results that each country has practically insured its line against a total interruption until such other duplicate lines can be laid as the growth of the business will undoubtedly warrant.

Thus in case the British cable between Canada and the mid-Pacific should be interrupted, it would only be necessary to route the British business for Australia, arriving at Vancouver, over the United States land lines to California to be transmitted over the United States cable to Hawaii, thence over the international span to Fanning Island, and on to Australia via the British line; or in case the American span to Hawaii is interrupted, the United States can likewise reach these islands and the East by routing traffic to Vancouver for transmission to Fanning Island, and thence to our trans-Hawaiian cable also via the international cable span.

In a similar way, in case any section of either through cable is interrupted beyond the Hawaii-Fanning span, the urgent United States traffic can be routed from Hawaii westward via Australia and thence to the East, or the urgent British business can reach Australia via Manila.

It is believed that such a living and equitable arrangement can be effected in the working of these Pacific cable systems as would afford security to each and result in mutual traffic advantages to both enterprises. Thus there is no reason why the present Atlantic cable system and the United States land systems should not eventually serve as material feeders to and from Australasia, and likewise the British and Canadian systems supply an appreciable traffic to the Philippines and the East.

CABLE CONNECTION WITH THE SAMOAN ISLANDS.

The interests of the United States in Samoa will be more clearly defined by the acquisition of sovereignty over the island of Tutuili now reported probable. In this connection another branch of cable is suggested, which the United States could properly assist. As shown upon the accompanying map, a span of cable but 650 miles in length, connecting Fiji with Apia, would thus join the Samoan group to the main British Pacific cable route and furnish cable connections for the three governments interested, viz., England, Germany and the United States.

CONCLUSION.

After several years of comparatively little advance, the technical and scientific side of telegraphy has received much attention during the past two or three years, until at this moment there is no other special branch of electrical engineering which is more in evidence or promises more for the future.

By whatever method the first Pacific cable is ultimately laid, and provided that it shall appear that all of the projected cable cannot be manufactured and laid in the United States within a reasonable time, it seems plain that the encouragement of American manufacturers in the building up in the United States of a deep-sea cable industry of the first class is a wise policy for this Government.

The successful completion of the submarine cable across the Pacific will mark an epoch in the telegraph history of the world. After thirty years of consideration—technical, commercial and political—the end of this century sees this great enterprise at last seriously undertaken. The full influence which it will exert upon the Western Hemisphere and the world in general is not easily appreciated. Strategically, the importance of this inter-colonial communication and its preservation are very great. However, the Philippine question should not overshadow the larger question—the Eastern question—in the consideration of this project. Important as the cable will be as a means of joining the Philippine archipelago to the United States, its larger importance will ultimately be in the future of the commercial development between the United States and the East. In the broad extension of the Pacific trade consequent upon the completion of the Isthmian canal and the development of steamship lines plying the Pacific, the telegraph cable will naturally become an important factor. The trans-Pacific steamship lines are heavily handicapped by the absence of a direct means of telegraphy between the ports embraced in their routes. Situated on the main trade routes leading from the Isthmian canal to Asiatic ports, the Pacific cable will serve as a powerful adjunct and support to this enterprise. The two go hand in hand and are mutually closely related. It can be stated that there is scarcely any point in the world where there is greater need for a central cable station than in the Hawaiian Islands. Geographically situated at the military and commercial strategic position of the North Pacific Ocean, it will ultimately serve as the distributing center of ocean communication between the two hemispheres, as well as to various island groups of the Pacific.

As to the probable traffic to be immediately expected there is little direct evidence at hand, since the waters spanned have never before been crossed by a submarine cable. Taking $150 as the average earning power per nautical mile of the long cables of the world as a basis, this project should prove a paying investment from the very first; but it is believed that this estimate, based upon the average of cables, will prove under rather than above experience, particularly as this route will immediately enter as a competitor for European traffic via the Atlantic cables and the United States land lines. The immediate effect of the trans-Pacific cables will be to lower the rates to the East, since European traffic will be open to competition, east and west, and the new Western route, due to the long spans and comparativeiy few repetitions, will have an advantage.

A short span of cable of about 200 miles between Luzon and Formosa connecting with the Great Northern Telegraph Company's route through Siberia and also between Luzon and a Chinese port, will bring Japan and China into direct connection not only with the North American continent, but also by two competitive routes east and west with Europe. In fact, the laying of the Pacific cable should operate to readjust the present cable through tariff rates throughout the world upon a lower basis.

APPENDIX No. 1.

TRANSATLANTIC CABLES—TABULAR STATEMENT OF ACTUAL AND CALCULATED SPEEDS.

Date When Laid.	Designation of Cable.	Length in Nautical Miles.	Type of Core of Deep Sea Cable. Pounds per Nautical Mile.	K. R. Ohm × Microfarads. = 10^6.	Speeds Actually Obtained in Words per Minute, Five-Letter Words.	Calculated Speed if Lengths 1,860 Nautical Miles.	Calculated Speed if Lengths 1,850 Nautical Miles and Core 400.
			Cop. G.P.				
1873	Anglo-American	1,876	400/400	4·910	.....	....	....
1874	Anglo-American	1,937	400/400	3·512	20·2 (a)	19·9	20·2
1875	Dir't United States	2,423	400/300	7·580	22·6 (b)	30·6	70·2
1879	Pouyer-Quertier	2,242	350/300	6·900	22 (c)	32·2	50·8
1866/80	Anglo-American	1,852	.....	4·632	.....	....	....
1881	Jay Gould	2,518	350/300	7·834	21·5 (d)	29·8	60·4
1882	Jay Gould	2,563	350/300	8·080	21·5 (d)	41·2	71·2
1884	Mackay-Bennett (S)	2,393	350/300	6·740	26	42·0	72·3
1884	Mackay-Bennett (N)	2,346	350/300	6·630	26	41·8	71·2
1894	Mackay-Bennett (3d)	2,161	500/320	4·671	40 (g)	54·8	77·2
1894	Anglo-American	1,850	650/400	2·420	47·4 (e)	47·4	47·4

(a) Report of engineers, Messrs. Clark, Forde & Company, to the manager of the Anglo-American Telegraph Company, dated June 25, 1877.

(b) Report of engineers, Messrs. Clark, Forde & Company, to the manager of the Direct United States Cable Company, dated June 25, 1877.

(c) Report of the engineer-in-chief, Mr. Von Chauvin, to the Pouyer-Quertier Cable Company, dated June 15, 1880.

(d) Report of Dr. Mulrhead to Mr. Von Chauvin, representative in London of the Western Union Telegraph Company, dated July 10, 1883.
(i) Special trial of code words, 18 words per minute; mean
(ii) Press messages, usual rate, 25 " " " } 21·5
(iii) As many as 135 letters per minute have been observed to pass at times without requiring repetition.

(e) Electrician, dated October 12, 1894.

(g) From a letter from Mr. G. G. Ward, vice-president and general manager of the Commercial Cable Company, dated May 10, 1895.

APPENDIX No. 2.

TRANSPACIFIC TELEGRAPH CABLE SURVEY.

[From Annual Report of Chief of the Bureau of Equipment, Navy Department, November, 1899.]

A practicable route for a submarine telegraph cable was established between San Francisco and Honolulu some years ago.

In order to continue the survey of the route from Honolulu to the Philippines, the U. S. S. "Nero," under command of Commander Charles Belknap, U. S. N., was very thoroughly fitted out and equipped for a deep sea exploration at the navy yard, Mare Island, during the early part of the present year. The "Nero" is a large steam collier purchased for use during the late war, and on account of great steaming radius was admirably adapted to make the survey. After a careful consideration of the subject, it was decided that the best route westward from Honolulu to the Philippine Islands was by way of the Midway Islands and Guam, landing the cable at a convenient point on the east coast of Luzon as near as possible to the latitude of Manila. It was also decided as desirable to survey a route from Guam to Yokohama. Elaborate instructions for the survey were prepared. The plan of the survey, which is represented on the accompanying chart, consists in carrying direct lines of soundings, taken at alternate intervals of 10 and 2 knots, from Honolulu to the Midway Islands, thence to Guam, and thence to Luzon, and also from Guam to Japan. The return course to be pursued is a zigzag line passing back and forth to equal distances on each side of the route followed in going to the westward, with soundings at intervals of 20 knots at the turning points.

The "Nero" sailed from San Francisco for Honolulu on the 22d of April. She sailed from Honolulu to commence her work on the 6th of May. On the 22d of May she had completed a single line of sounding to the Midway Islands, by July 4 to Guam, and by August 1 to Luzon.

Along this route, which is 4,812 knots in length, 853 soundings were taken. The characteristics of the bottom soil and the temperature of the surface water were observed at each sounding station, and these, together with the meteorological record and the frequent observations of specific gravity, bottom temperature, and the currents of the ocean, besides their value in laying a submarine cable, will form an important contribution to the physics of the Pacific Ocean.

Two offsets from the projected great circle route between the Midway Islands and Guam were found to be necessary in order to avoid obstacles to a successful

laying and operation of a telegraph cable. The first of these obstacles encountered is a submarine mountain situated a short distance westward of the Midway Islands and rising from the floor of the ocean, which here sinks to a depth of 2,200 fathoms, to within 82 fathoms of the surface. The second obstacle is one of the deepest submarine abysses yet found in the world, situated about 500 miles eastward of Guam, and sinking to a depth of more than 4,900 fathoms.

Reports have been received of the preliminary line of soundings from Honolulu to Luzon, and they indicate that the route which is being surveyed will prove entirely practicable.

No reports of the soundings taken on the return trip or of any soundings from Guam to Yokohama have been received.

Owing to illness, Commander Charles Belknap, U. S. N., was relieved from the command of the "Nero" at Manila by Lieut.-Commander H. M. Hodges, U. S. N.

The expenses of this survey, so far as this bureau is concerned, have been entirely defrayed from its current appropriations.

HYDRAULIC CEMENTS.

By WILLIAM S. MACHARG, C.E.

THE application of hydraulic cements in building construction has increased of late years to such an extent that its manufacture is becoming one of the great industries of the country. This increase is by no means due to its use to a larger extent in the class of work to which it was originally applied, but rather to invasion of new fields, and to the displacement of other materials.

Originally used as a binding material in stone or brick masonry in subaqueous work or in work exposed to the action of water, it has now, in many structures, displaced the former principal components, or rather combined them in a less costly but integral form, as concrete, furnishing a monolithic mass unattainable in ordinary masonry. In common structures, in foundations and in elaborate masses the primary plasticity of concrete and its ultimate great strength, equal or superior to that of most building stones, together with its monolithic character, make it an invaluable building material.

Recent combinations of concrete with steel tie rods, beams, and especially plate girders, have opened a new field in the covering of large areas and building permanent bridges, which it is yet hard to value. An arch of concrete is much stronger than an equal arch of brick masonry, and an arch in which steel beams bent to the curvature of the intrados are embedded in concrete is far stronger than the first. The relative strengths have not yet been accurately determined, probably because the field is new and the materials comparatively inexpensive, but these works are rapidly increasing in number and importance, and we shall soon undoubtedly have definite determinations of the economic values.

While hydraulic cements, perhaps both natural and artificial, were used by the ancients, yet the hydraulic cement of commerce is a modern discovery, dating back less than one hundred and fifty years. In the year 1756, John Smeaton, C.E., seeking for a proper mortar to be used in rebuilding in stone masonry the Eddystone lighthouse, which had been swept away, found that the quality of setting under water possessed by hydraulic limes was due to the presence in the limestone of clay, and secured the excellent mortar used in that structure by mixing blue lias hydraulic lime from Aberthaw and pozzuolana from Civita Vecchia. It was not until 1796, however, that a true hydraulic cement appeared, when Mr. Parker, of London, took out a patent for the manufacture of what he called "Roman" cement, which was made from septaria, nodules of natural cement rock, calcined and ground to powder. Other natural cements were found in Europe, and experiments were made in the production of artificial cement, and in 1824 an English patent was granted for "Portland" cement.

In the United States cement rock was first discovered and natural cement made in 1818 near Fayetteville, New York. Other cement rocks were discovered within a comparatively short period, and the manufacture was commenced of many now well-known natural cements. It is of local interest to note that cement rock was discovered at Utica, Illinois, in the year 1838, and that cement has been made at that point continuously since.

The manufacture of Portland cement was attempted about 1865 by Mr. Saylor, in the Lehigh valley, but the work for some time was experimental, and while it continued, a true Portland was made to a small extent at Kalamazoo, Michigan, in 1872. The growth of the industry was slow in the United States, as is shown in the following table made from official figures given by Mr. Robert W. Lesley in The Journal of the Franklin Institute, November, 1898, of the amount and origin of the Portland cement used in this country, years showing marked change in domestic being selected:

	American.	Foreign.	Total.
	Barrels.	Barrels.	Barrels.
1882	85,000	370,400	455,400
1885	150,000	554,396	704,396
1887	250,000	1,514,095	1,764,095
1892	547,440	2,440,654	2,981,094
1894	789,757	2,638,107	3,427,864
1896	1,543,023	2,989,597	4,532,620

From another source the figures for last year are taken, the quantity imported being approximate:

	American.	Foreign.	Total.
1898	3,698,248	2,000,000	5,698,248 bbls.

During the year 1898 there was also manufactured in the United States 8,276,424 barrels of natural cement.

While the manufacture of American Portland cement has increased so rapidly during the last few years as to shut out foreign cements largely except in seaboard cities, the demand has been such that derangement in transportation facilities has often produced local shortages of supply. As a result many new mills are being erected throughout the country.

The past twenty-five years has seen a great improvement in the quality of Portland cement, due in part to the use of better machinery, and in part to the exercise of greater care in the selection and proportionment of materials, and these improvements have been brought about principally by the general and systematic examination and testing of the cements offered in the market. Cement testing has been made easy by the provision of special apparatus of little cost, and it is unusual now for any work using a considerable amount of cement to be carried on without continuous testing of the cement offered. A new class of mechanics has therefore come into existence known as cement testers. The term mechanics is used advisedly and without any invidious meaning. The manual and operative process of cement testing is purely mechanical, and attempts have been made to secure uniform results by regulating and fixing the steps in the process, and even by the introduction of machinery in the preparation of the test pieces. Uniformity is to some extent desirable, and yet this desirability is limited. As a building material hydraulic cement differs from all others, except lime, in this great and essential feature, that it is an unfinished product; that is, that after introduction into the structure it proceeds to its final office and state. This condition, together with allowable variation in its composition, renders the tests which are made to establish the quality of the unfinished material indicative tests and not proof tests.

Fortunately the large laboratories where cements are tested are in the control of persons qualified to pass judgment on these indicative tests, but there exists a danger in the common system of general testing which may bring serious injury upon the cement industry in this country. Taken in conjunction with the ordinary American desire for improvement, and the wish or necessity for quick returns on investments, mere mechanical testing—assuming that if certain qualities approved by tradition are good, the same qualities exhibited in a higher degree are better—may result in the production of a material which will eventually wreck many a well-planned structure.

The chemistry of hydraulic cements, both in the requirements of manufacture and in the final process of setting, are by no means agreed upon even by the eminent men who are making it their life study. Michaelis, Le Chatelier, and Newberry, with others, are gradually evolving a firm basis upon which manufacture may proceed with more certainty, but at the present time the only absolute proof test of an hydraulic cement is time.

It is in Portland cements that the danger spoken of is chiefly to be feared. Competition is fierce, and as the material is purely artificial, some added material being necessary even in the rock Portlands to secure correct proportions, demands by the consumer, even when not based on correct judgment, will be met by the manufacturer.

It must be borne in mind that the manufacture and use of Portland cement dates back only seventy-five years, and for a good many years its use was attended with many failures. Thirty years ago careful and judicious American engineers did not care to trust Portland cement concrete in important foundations or heavy structures. It was through the careful and intelligent work of Grant and Faija, largely, that English manufacturers were brought to recognize the need of care and exactness, and that certain brands of English Portland cement acquired a reputation for stability and other good qualities. A great impetus was given to the use of concrete by the building of Port Said, where this material was used exclusively; the binder, however, in the Port Said concrete was a natural product, the hydraulic lime of Teil. About this time the Germans entered upon the manufacture of Portland cement with their usual methodical care, and produced good material. As a consequence of all these conditions, concrete has advanced rapidly as a building material.

From the early successes and failures of Portland cement in mortars and concretes certain deductions were made which have become traditions, and, as in most traditions, the origin has become obscured. One of these traditions is that the slowest-setting Portland cements are the best, and the class of testers above referred to accept this maxim without limitation, apparently without knowledge of its origin. The early users of Portland cement found from experience that cements which commenced setting very quickly, or which acquired a very great strength in a short time, say a week or less, were likely to "go back" or retrograde, and that this might even proceed to disintegration in time. They also noted that these qualities, that is, quick commencement of set and rapid continuance to great hardness, were apt to be combined in the same cement; hence the deduction. These conditions, singly or united, were an indication that either in proportioning the components or in the processes involved, something was wrong, and the cement likely to be unsafe.

At the present day, under the pressure of competition and under the warrant of testers, the early strength of cements is being gradually forced up, and the time of the apparent occurrence of initial set is being retarded by the admixture of gypsum. Why should the addition of 2 per cent. of gypsum change the inherent qualities of a cement which would have been rejected thirty years ago on its abnormal strength at the age of seven days? What significance has the artificial delay of the initial set for two or three hours? If time is the only proof test of works in Portland cement, why should changes in method which may be vital be allowed to, or rather forced upon, manufacturers upon the sole warrant of mechanical laboratory tests?

There has been a considerable legitimate improvement in Portland cements within the past thirty years, and credit must be given for it to the careful, intelligent study in laboratories, but there must be a distinction made between this study and the common inspection tests made upon work, and the influence of the latter upon manufacturers must be limited. Such limitation can only come from intelligent supervision, and it is upon architects and engineers that this responsibility rests.

The value of different qualities in Portland cement depends entirely upon how or where it is to be used. For instance, the extreme hardness attained by some cements in a short time is only valuable where the work is to be quickly exposed to abrasion. A driveway or walk is an example of such work, and this is easily and at small expense replaced if anything is wrong with the cement. In the case of footings in a large building, or foundations for heavy machinery, however, the cost of renewal includes vast expenses, and the original conditions do not require an extraordinary degree of strength or hardness in the cementing material, therefore stability should be the quality particularly sought, and indications possibly inimical to this quality should be given great weight in the selection of material. Engineers are beginning to realize this danger, and some recent specifications contain a limiting maximum strength at seven days which is much below that set forth as desirable in many American Portland cements.—The Building Arts.

THE METRIC SYSTEM.

A VIGOROUS movement has been undertaken in Congress, says The Iron Age, to secure the adoption of the metric system of weights and measures, beginning January 1, 1901, with the understanding that the system shall not be compulsory upon the people until the beginning of the year 1903. Within the past month a measure has been introduced by Representative Shafroth, of Colorado, providing for the adoption of the system for all purposes except the completion of the land surveys which have already been begun upon the English system and which cannot well be finished on any other basis without producing unnecessary confusion. Mr. Shafroth's bill is as follows:

"Be it enacted, etc., That from and after the first day of January, 1901, all the departments of the Government of the United States, in the transaction of all business requiring the use of weight and measurement, except in completing the survey of public lands, shall employ and use only the weights and measures of the metric system; and from the first day of January, 1902, the weights and measures of the metric system shall be the legal standard weights and measures in the United States."

It will be seen that this measure is similar in its most important features to that presented in the Fifty-fifth Congress by Representative Stone, of Pennsylvania, and which passed the House, but was subsequently recommitted by a narrow majority. Mr. Shafroth has brought the measure forward at the solicitation of a large number of advocates of the adoption of the system, including the National Metrological Association, of which Prof. J. Howard Gore, of Columbia University, of this city, is secretary. With regard to the advantages which the advocates of this bill assert would accrue from its passage Mr. Shafroth said to the correspondent of The Iron Age:

"In my opinion the time has now arrived when we should abandon the time honored, cumbrous English system of weights and measures and adopt the method which has already been accepted by the leading civilized nations of the world. It is especially appropriate that in entering upon a new century the United States should step into the front rank of progress, adopting well tried, modern methods of extending its influence in every direction. We have already become one of the leading commercial nations of the world, and in recent years we have made rapid strides in our foreign commerce. We are employing all legitimate means to extend our foreign trade, and our recent territorial expansion has emphasized the importance of neglecting no step so important as the adoption of this almost universal system of weights and measures. Especially is our trade expanding in South and Central America and in the Orient, an expansion that in the future will be much more rapid than in the past, owing to our recent acquisitions. In all of these countries the metric system is the standard.

"In the markets I have mentioned we find as our chief competitors Germany and Great Britain. Germany has employed the metric system for many years, greatly to the advantage of her foreign commerce, and while Great Britain has always controlled a large foreign trade, there is ample evidence in the reports of her consuls and of her leading trade bodies that the adoption of the metric system would have enabled her manufacturers, merchants and exporters to resist more effectively the encroachments of Germany and other nations. English merchants have been obliged to employ trade price lists in which both the English and the metric systems are used, and in addition the good offices of English banks throughout the world have been invoked to extend and maintain British commerce. How much greater England's supremacy would have been had she adopted the metric system twenty years ago can only be imagined.

"I am well aware that there has always been a strong prejudice among many important manufacturers of machinery, tools, etc., against the adoption of the metric system, but I think that this prejudice is gradually disappearing and will grow less and less as our foreign trade expands. In no department of American manufacture has there been so important a decrease in importations and increase in exportations as in the iron and steel trade. We are putting our manufactures of metal into every market of the world in rapidly increasing quantities, but there can be no doubt that if gauges, weights, dimensions and measurements of all kinds which we employ were based upon the almost universally adopted metric system our manufacturers could make and sell large quantities of goods which they cannot now place abroad. It is significant that so long ago as 1896, when the Stone bill was pending in the House, the Association of American Steel Manufacturers, at a meeting held in Steelton, Pa., adopted the following resolutions:

"'Resolved, That this association hereby indorses House of Representatives bill No. 7251, establishing the metric system of weights and measures and requesting that the individual members of the association correspond with their Representatives and Senators urging its passage.'

"The firms and corporations represented at the meeting were as follows: Jones & Laughlins, Pittsburg, Pa.; Carnegie Steel Company, Pittsburg, Pa.; Cambria Iron and Steel Company, Johnstown, Pa.; Bethlehem Iron Company, South Bethlehem, Pa.; Central Iron Works, Harrisburg, Pa.; Pottstown Iron Company, Pottstown, Pa.; Illinois Steel Company, Chicago, Ill.; Carbon Steel Company, Pittsburg, Pa.; Park, Brother & Company, Pittsburg, Pa.; Lukens Iron and Steel Company, Coatesville, Pa.; Pennsyl-

vania Steel Company, Steelton, Pa.; Colorado Fuel and Iron Company, Pueblo, Col.

"About the same time the Philadelphia Engineers' Club adopted similar resolutions advocating the metric system, and other engineering experts gave it their hearty support. The testimony as to the adoption of this system by other nations, especially concerning the embarrassments encountered during the period of transition from the old to the new system, is all to the effect that the change has been made without any serious difficulty. Germany changed to the compulsory system in two years and Austria in three without friction or trouble. Merchants displayed the new weights and measures in advance, curiosity fixed them in the minds of the people, pride in displaying their ability to grasp the use of them led people to call for commodities in their new terms in advance of the prescribed time, and when the time came to make the change it was already made. Mr. Siemens, the noted German engineer, testified as to the introduction of the system in his own works, saying that it was all a matter of about a fortnight or three weeks. 'As far as I recollect it,' he added, 'the metrical system was very largely adopted throughout Germany between January 1, 1870, and January 1, 1872, during the optional period. It was very largely adopted then and was found to work so well that when the compulsory time came there was nobody to be compelled.' Another large manufacturer of steam engines and boilers, in testifying before the English Parliament committee which recently investigated the advisability of adopting the system, said:

"'Before coming here this afternoon I asked four or five of our men privately (not through the works' manager) what they thought of the system which we adopted a short time ago. There was not a dissenting voice among them, and especially they all agreed at once that millimeters were very much easier to work to than the English measurements.'

"I think the people of England are becoming thoroughly aroused to the necessity of changing their method of weights and measures, but they are extremely conservative and it may be years before the change is made. It will therefore be additionally to our advantage if we take the step first, and I think the adoption of the metric system by the United States would enable us to make great gains in our commercial standing in every quarter of the globe.

"I have provided in my bill that the new system shall not be formally adopted until January 1, 1901, in order to give ample time for such readjustment as may be necessary. My bill also stipulates that the system shall for the first year be compulsory upon the departments of the government only, and not until 1902 shall the weights and measures of the metric system be the legal standards. I do not doubt that in the space of one year during which the system is employed by the government, the people will become fully educated to its use and enthusiastic for its complete adoption.

"I have spoken so far only of the trade advantages to be secured, but there is a most important feature that should not be overlooked. The system is convenient and economical in practical use, and to the nation that appreciates so fully the advantages of the decimal system in its coinage and currency no argument or demonstration of the wisdom of transforming its weights and measures into a decimal system would seem necessary. The saving of time in the education of the young that would result from the change has been estimated with considerable unanimity by educators, but the saving in all the practical operations in subsequent every-day life is beyond the possibility of intelligent estimate. The report of the committee of the English Parliament which recently investigated the question states that 'no less than one year's school time would be saved if the metrical system were taught in place of that now in use.' This is corroborated by the estimates of educators in this country, some of whom concur in the English estimate of an entire year in the child's school life, while others limit it to the saving of a year in the time given to arithmetical instruction. Taking it on either basis and remembering that according to the reports of the Commission of Education, there are in the public and private schools of this country more than 15,000,000 school children, the aggregate loss may well be said to be appalling. The opponents of the adoption of this system—if indeed any are now seriously opposed to it—will hardly care to assume the responsibility for the continuance of a condition of affairs in which 15,000,000 years of human life may be said to be needlessly wasted."

ICE UPON THE COAST OF THE BLACK SEA.

THE Russian port of Novorossisk is situated upon the north coast of the Black Sea, at the western extremity of the Caucasus. It belongs to the province of Kouban. Although it is in nearly the same latitude as that of Venice and Bordeaux, it is occasionally submitted to attacks of extremely cold weather. During the last days of December, for example, it was visited by a terrible storm that lasted for a whole week. The wind blew in a gale from the northeast with a velocity exceeding 130 feet per second, and the temperature dropped from +10° to −20° and even to −24° C.

The damage done in the factories and stores that compose the city is estimated at more than two hundred thousand dollars. In the bay, and even in the port, the maritime disasters were numerous.

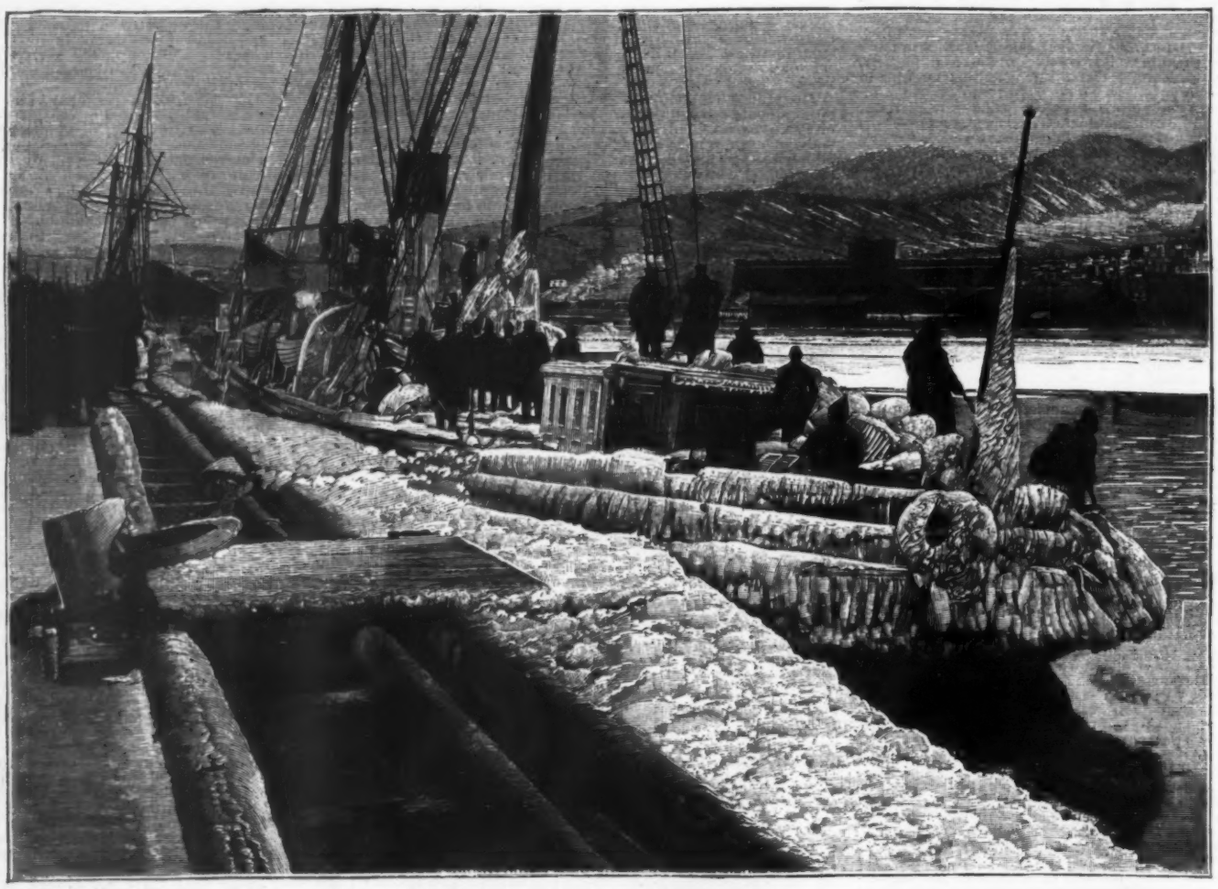
The steamer "Igor," belonging to the Russian Navigation Company, a packet boat for the carriage of passengers, sailed head to the wind for an entire day. With its two anchors dragging and its forward engine running at full speed, it nevertheless managed to come about and reach a point about opposite the Court of Justice. Here, at about 130 feet from the wharf, it landed its passengers upon the ice. Another steamer, anchored at the jetty and protected thereby from the wind, was completely covered with ice.

A sailing vessel caught by the tempest in the offing succeeded in re-entering the bay, but it was no longer steerable, and its sails, in great part frozen, were torn, or, it might be said, broken. While at 300 yards from land, the ice formed almost instantaneously, and the vessel was thrown on the coast and rendered immovable. The crew disembarked upon the ice.

Some other sailing vessels were treated still worse. Those that were able to regain the port were soon enveloped in a shell of ice, and the chains and cordage were so heavily loaded as to break.

The view of the Court of Justice presented herewith gives some idea of the effects produced upon land. This building, which is situated at more than 500 feet from the sea, had the side exposed to the wind covered with ice due to spray.

Novorossisk had already been submitted to violent storms from the northeast during which the velocity of the wind reached 140 feet per second and the temperature 24° C. below zero; but the bay, however, had never been frozen. The freezing in December occurred especially in the western part of the bay, which is not very deep, and which was wrongly selected last year as a spot for the final enlargement of the port. The construction of a mole created a true lagoon without sufficient communication with the sea, which is more difficult to cool. After a change of plans, the government had begun work to the east of the bay. On this side, there were no accidents, and but little or no ice was formed. The business population of the city bitterly regretted that the advice of the government engineers in regard to last year's work had not been followed. The new basin, poorly sheltered and of inadequate depth, will add nothing to the prosperity of Novorossisk, and has already cost it its reputation as a port that never freezes.—L'Illustration.



STEAMER "IGOR" COVERED WITH ICE.

SCHWEITZER SYSTEM OF BREAD MAKING IN PARIS.

THERE has recently been created in Paris a society for establishing in all the populous centers of France combination milling and baking houses, operated by machinery known as the "Schweitzer system," says Consul Atwell, of Roubaix. The object is to furnish 100 kilogrammes of nutritious and digestible white bread from 100 kilogrammes of grain at the lowest cost of production.

The model establishment, which is at La Villette, Paris, opened its doors to the public on June 15, 1899. It may be visited on Sundays by those desirous of studying its operation.

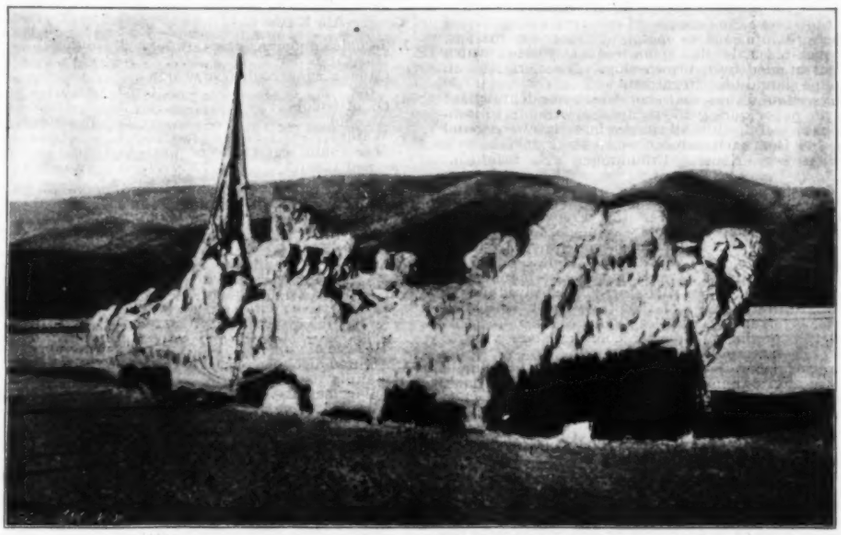
At a meeting of the society, December 2, a report was made concerning the success of the effort to supply good bread at a low price to the Parisian public. In the bakery at La Villette alone, the daily sales rose from 1,900 francs ($366.70) on September 1 to 4,000 francs ($772) on November 30, and a corresponding increase was noted in the branch houses, which are most liberally patronized in the wealthy quarter of Paris. Official analyses by the National Agronomical Institute and by the municipal laboratory of Paris demonstrate that the Schweitzer bread contains more nutritive nitrogenous properties than ordinary bakers' bread and more than double the phosphates in the latter. The bread, known as family bread (pain de menage), is sold to the working classes at 25 centimes the kilogramme (4·82 cents per 2·2046 pounds), that is, 10 centimes per kilogramme (1·93 cents per 2·2046 pounds) less than the usual price.

The Villette establishment is a building of iron and stone 157 meters (515 feet) long, situated on a canal, and constructed at a cost of about 1,000,000 francs ($193,000). A steam engine of 150 horse power supplies the power

and produces the electricity necessary for lighting purposes and for charging the accumulators of the delivery wagons.

Just as coffee is better if freshly roasted and ground, so, Mr. Schweitzer says, bread is better if made from freshly ground wheat. The flour in this mill, which is a part of the establishment, is ground only in quantities sufficient to meet the daily needs of the bakery.

The wheat arrives in a boat, which is moored in the canal; elevators hoist it into bins, whence it is carried by an immense elevator to the top of the mill and turned into the different cleaning and separating machines. After all foreign substances have been removed and the grains of wheat have undergone a thorough brushing and washing, they are clean and shiny; but the grooves of the wheat sometimes retain



SAILING VESSEL DRIVEN ASHORE AND INCASED IN ICE.

a little dust. This is completely eliminated by a Schweitzer appliance, which, seizing each grain lengthwise, splits it exactly in the groove.

The wheat thus cleansed passes into the mill, composed of flat, circular steel grinders, grooved in such a manner that they accomplish the decortication of the kernel and its granulation into meal at the same time. These grinders are movable, but do not touch; so that, instead of crushing the wheat and producing a flour in which the starch only is retained, the outer and harder portion of the wheat, containing gluten and other nutritive properties, is retained in the flour. The bran alone is expelled.

Attached to the mill are the works for kneading the meal, water, and yeast into bread. All of this is done mechanically, the works being separated into three stories. Special yeast is prepared in the upper story in rooms heated in winter and cooled in summer. The yeast, flour, and the salted and filtered water are carried down by machinery into kneaders in the form of half cylindrical tubs, rotating on two pivots placed in the axis of the kneading troughs, so that the tubs may be placed at a lower or higher angle in order to accelerate or retard the kneading.

One person can attend to two Schweitzer kneaders, regulating the distribution of the dough, and thus the kneading of 2,000 kilogrammes (4,409 pounds) of dough per hour is accomplished.

The steel arms of the mixing and kneading machinery, some of which are stationary and others mobile, stretch and work the dough much better than hand power.

The wheat, salted water, and yeast automatically enter one end of the tub, and dough in an endless skein of pale yellow issues from the opposite end. This dough finally falls on tables on the ground floor, where it is weighed and made into bread of every shape and dimension. Small wagons are charged with the shapes, which then go to the raising room. Each floor has a fermenting room kept at an even temperature.

The dough, after raising, is carried by wagons into the baking room, where it is placed in Schweitzer ovens heated by gas from retorts arranged in such a manner that the gas does not enter the oven, and the heat is so regulated that the baking operation goes on automatically.

Twice a day, once before dawn and in the afternoon, ten large two-horse wagons (which will be used until the electric carriages shall have been built) distribute the bread in the different depots of the Société Parisienne in Paris.

In connection with this model establishment is a laboratory for the chemical examination of the samples of wheat submitted for purchase. These are, upon their arrival, ground and passed through a sieve by a small hand bolting mill, invented by Mr. Schweitzer, which determines immediately the nutritive volume of the grain in gluten and nitrogenous matter.

Mr. Schweitzer has mills, ovens, and kneaders of various dimensions that may be worked by machinery or hand power. The latter system enables the farmer to grind his own wheat and make his bread from an unadulterated and wholesome product. It is regarded as particularly adapted to the colonies.

The Schweitzer system will be on exhibition at the Exposition of 1900.

Trolley-express cars will be run between Stamford and New Haven, a distance of fifty miles. This would be a great convenience in summer at the shore resorts between the two cities.

THE ELECTRICAL POTENTIAL OF THE ATMOSPHERE, REFERRED TO OTHER CONDITIONS.

By Prof. EDWIN G. DEXTER, Ph.D.

IN a paper which appeared in the SCIENTIFIC AMERICAN SUPPLEMENT of June 3, 1899, I gave in part a study of the police records of New York city, referring the misdemeanors there recorded to the weather conditions under which they occurred. The results seemed to demonstrate the fact that certain meteorological conditions are productive of, or at least accompanied by, unusual numbers of misdemeanors in the public schools and penitentiary, of suicides, of arrests for assault and battery, and of initial attacks of insanity, besides affecting in a marked degree the death rate. It was shown that most of these classes of data were excessive during low conditions of barometer and humidity, high conditions of temperature and wind, and on days which are characterized by the Weather Bureau as "clear" (the brightest days), and on those on which there was no rain or snow fall. These facts were especially true for misdemeanors in the public schools and penitentiary, and an extended study of suicide, made since the publication of the paper alluded to, has shown that those conditions bring about a marked increase in the numbers of those who seek self-destruction. In attempting to account for the unusual number of active misdemeanors during the most invigorating meteorological conditions, a higher electrical potential of the atmosphere was hypothetically postulated. In the dry atmosphere of the Colorado altitudes, there seems little doubt that such is the case. Man and brute feel it, and the resulting neurotic condition sets every one's nerves on edge. An empirical study of the police and school records for the city of Denver, Colo., showed six times as many misdemeanors during conditions of very low humidity and very high winds as at other times, and since such a combination seems likely to be productive of static electricity, an explanatory hypothesis was based upon its existence. Yet it was recognized as an hypothesis, pure and simple, and in this paper I outline a modest attempt to show the relation between the electrical potential of the atmosphere and other meteorological conditions.

The study is based entirely upon T. C. Mendenhall's "Report of Studies of Atmospheric Electricity," which appeared in 1889 as a memoir of the National Academy of Sciences. This comprises all the work done by the Signal Service in an attempt to investigate the value of electrical observations as an aid to weather forecasting. The mass of material collected cannot fail to be of value for subsequent study. For the years 1882 till 1889, stations were maintained for a part or all of the time at Washington, D. C., Baltimore, Md., Cambridge, Mass., New Haven, Conn., Ithaca, N. Y., and Columbus, Ohio, where, under competent observers, the electrical potential of the atmosphere was determined by means of very delicate and expensive instruments each day, at intervals varying from a few seconds to several hours. Of the many interesting facts brought to light by this study, I have used but one; the mean potential for each day as recorded at the Ithaca station. The records from this station were not chosen because they might prove more interesting than those from any other, but because they gave certain other meteorological data for each day which could be used for purposes of comparison. These appended data had to do only with the character of the day, the wind and the precipitation. Neither the temperature, the barometer nor the humidity were given, so that we have no data bearing upon them, except as the latter may be inferred from the character of the day. The study, as set forth in this paper, consisted simply of a tabulation of the mean potential for each day with reference to the other conditions given for the day, for the purpose of discovering under which of the latter the potential was normally high or low. As an illustration of the records from which I have worked, I give those of a few days from the Ithaca report:

JUNE, 1887.

Day.	9 a. m.	11 a. m.	1 p. m.	3 p. m.	Mean.	Remarks.
1	208	88	14	139	111	Br. Cl'dy. Rain.
2	88	−181	256	95	53	Lt. Cl'dy. Rain.
3	−44	11	11	23	0	Cloudy.
4	66	2	62	15	41	Fr. Clear.
5	167	84	71	100	104	Lt. Cl'dy.
6	154	137	57	137	121	Lt. Rain.

The numbers refer to the electrical potential in volts, under "Remarks." The first abbreviations refer to the velocity of the wind, and have been interpreted for me into terms of miles. The other abbreviations indicate the character of the day and the precipitation. The means for each day represent the algebraic sum of the observations for the day.

The following table shows the mean potential for each of the meteorological conditions alluded to in that column in course of the report:

Character of day.			Wind.				Precipitation.	
Clear.	Pt. cl'dy.	Cloudy.	3-5	6-14	15-29	30-39	None.	Some.
93	68	56	52	126	151	254	52	80 (?)

As may be seen by the table, the potential is the highest on clear days (93 volts) and those having considerable movement of the wind (254 volts for velocities of from 30 to 39 miles per hour), decreasing as the moisture increases (52 volts on rainy days), and as the wind subsides (52 volts for velocities of from 3 to 5 miles). The records did not furnish data for the determination of the potential, so this was approximated by taking the average of the potentials for clear and partly cloudy days.

This study corroborates in a very decided manner the hypothesis stated in the paper alluded to, and also in a more extended article on the same general subject (see "Conduct and the Weather," Monograph Supplement, No. 10, The Psychological Review).

We cannot, however, claim for it a very broad bearing, simply that the figures are true for a limited study made from the records of a single station. That they would prove valid for any other locality, we cannot be certain. No electrical data are obtainable for New York city or Denver, Colo.—the cities to which my studies of the influence of the weather upon mental states have been limited; and as they can only be obtained by the use of very expensive instruments, are practically impossible, except under the direction of the Government. Until it is done, we must rest content with analogies based upon studies made elsewhere.

COURT OF JUSTICE OF NOVOROSSISK.

POWER FROM TRENTON FALLS.

By L. P. GRATACAP.

TRENTON Falls has enjoyed in the past a distinct celebrity among summer resorts, and thirty or fifty years ago the New Yorker found the well traveled road of nuptial excursions led to this beautiful and secluded spot.

It is a natural gorge, which, except for its moderate dimensions, might be properly designated as a cañon. Its ancient popularity, for reasons which are to be found in local changes and a divergence of fashionable travel into more pretentious channels, has disappeared.

This wild chasm, animated by the cataracts and falls, and the innumerable lesser charms of a winding stream, alternately shaded between its straitened and sculptured walls, or flooded with sunlight in its wider portions, remains to-day a feature of delicate and romantic loneliness. The unsparing hand of commercial enterprise has invaded it. Its waters now chasing their untrammeled course under the lights and shadows of the tree-crowned cliffs are soon to be engaged in turning turbines and manufacturing light and power for the industrial needs of Utica. To many who recall their associations with Trenton Falls, this utilization of its natural power will awaken interest and regrets.

A word of description is appropriate before mentioning the installation now in process by the Utica Light and Power Company.

Trenton Falls is properly a succession of falls occurring in the course of the West Canada Creek, in a gorge, cut in Trenton limestone, and extending, from the little village of Prospect in Oneida County, for two miles, to the almost insignificant hamlet of Trenton Falls itself, some thirteen miles from Utica. The height of the walls of the gorge varies from 150 to 200 feet, and most significantly express their origin, in aqueous solution and erosion. The chasm, irregularly widening at the falls, where it has an average width of one hundred and fifty or more feet, is scarcely more than thirty feet from wall to wall in its narrow portions. Toward Prospect another fall occurs, and here at about the entrance of the cañon the width is again increased.

Enormous glacial accumulations of sand forming hills and ancient beach boundaries are observed on every side. The road-bed of the Rome, Watertown and Ogdensburg Railroad is laid on a hill of morainal character. Toward the northwest in the direction of Hinckley the hills bordering the carriage road, and on both sides of the West Canada Creek, are of glacial origin, and high banks of sand running eastward from the road to Utica show still more clearly and abundantly the presence here in the past of an impound for water, held between these banks of sand. Some secular elevation or warp has tilted the inclosed waters southward. They spilled over the lip of the morainal inclosure, and in large volume widened and deepened the breach and wore their way to the underlying Trenton limestone beds. A crevice or a depression determined the course of the wasting stream, and then circled by the incessant and effective weathering of this shaly rock and unequally stable rock, the gorge was begun. The recession of the falls from Sherman Falls is to-day obvious, and it would only require a longer period before the series of three separate falls became an extended slope, as the vertical steps declined into slanting banks, and the distance from the top of High Falls to the foot of Sherman Falls became an irregular long slide.

We may imagine the falls once at about the present station of Sherman Falls, where, to-day, a resistant bed of limestone eaten away into a sort of alcove still maintains its place, and that the falls receded, as weakly coherent layers of rock were displaced, and the overlying beds broke down when deprived of their support. The original single fall has become a separated series, from Milldam Falls at the top, through the two sections of the high falls, and terminating with Sherman Falls just at the entrance of "The Narrows," the deep and narrow channel below the hotel steps.

Pot holes abound in the course of the creek, and the very striking variations of depth in "The Narrows," as shown by Engineer Jenkins, show the varying conditions of rock and the contrasted volumes or velocity of water that hane made these different excavations, as well as pointing to the probable location of falls originally in this portion of the gorge.

At a point near the hotel steps the plummet sinks forty-five feet, while not more than fifteen to twenty-five feet prevails around it.

It is proposed to erect a dam a short way above the bridge of the Mohawk and Malone division of the A. & St. L. Railroad, and to carry the water in a circular flume about 2,300 feet along the edge of the gorge and adjoining it, where it will be carried in a steel flume to the bottom of the gorge at Sherman Falls, where the power house will be located. The pipe from the power house to top of the gorge will be nearly vertical and 125 feet in length.

The power obtained may reach 5,000 horse power. A line of transmission capable of delivering 3,000 horse power in the city of Utica will be laid. In Utica the high power current will be transformed to currents of low voltage.

J. W. Jenkins is the engineer in charge, and already the necessary excavations above the bridge have been made for the dam-site, and this month will see the beginning of operations in the beautiful rocky recess below Sherman Falls, where the power house is to be located. Industrial enterprise will largely now modify the beauty of this wonderful ravine.

Coal and Iron Structure Wanted in Brazil.—The following cablegram, dated January 30, has been received from Minister Bryan, at Petropolis, Brazil:

San Francisco Railroad requests bids 5,000 tons soft coal yearly. Also all catalogues iron structure.

According to a report from the British consul-general to his government in 1897, the San Francisco Railroad (Estrada de Ferro de S. Francisco) is in the state of Bahia, and had, at that date, 281 miles under traffic. To obviate delay, bids for coal and all catalogues relative to iron structure should be addressed and mailed direct to Hon. Charles Page Bryan, envoy extraordinary and minister plenipotentiary of the United States, Petropolis, Brazil.

TRADE NOTES AND RECEIPTS.

Sharp Impressions of Coins, Medals, etc., are obtained, according to Böttger, with the following mass: Mix molten, thinly liquid sulphur with an equal quantity of infusorial earth, adding some graphite. If a sufficient quantity of this mass made liquid over a flame is quickly applied with a spatula or spoon on the coin, etc., an impression of great sharpness is obtained after cooling, which usually takes place promptly. Owing to the addition of graphite the articles do not become dull or unsightly.—Deutsche Malerzeitung.

Practical Test for Paper.—Cut out 3 pieces, 20 to 30 cm., of the paper to be tested, fold each in the middle, place a piece of silver leaf of suitable size within and fold the three open edges once. Now, lay the papers upon beakers about 9 cm. in diameter, and expose them for two hours to the vapors of boiling distilled water. Brownish or blackish specks on the underside of the silver foil prove the presence of substances in the paper which are injurious to metal. If soot was present, brownish-black, dot-like spots frequently occur, which are surrounded by a brown ring. Discolorations on the edge should be disregarded.

Kayser found that coal soot which accidentally got into the paper during the manufacture rendered it injurious to metal, while all the raw materials were found to be free from such substances as attack metals, by a previous test.—Neueste Erfindungen und Erfahrungen.

Production of Colored Varnish Coating by Means of Alizarine Dyestuffs.—After the French patent of Jacob Perl, various attempts were made, following the introduction of celluloid varnish, which permitted the production of colorless coatings by immersion, to obtain colored coatings as well, in the like manner, yet in the majority of cases these attempts proved unsuccessful, owing to the fact that the varnish settled in thicker layers in the cavities than on the raised surfaces, thus producing a darker coloring, and giving to richly decorated objects very irregular tints. Attempts were also made to color objects coated with celluloid varnish by dipping them into dyestuff solutions. Although this process furnished good results when properly carried out, it was, nevertheless, abandoned for a long time, as unskillful practice could only produce unfavorable results. The coatings lacked transparency and the colorings were too sensitive to sunlight.

According to the experiments and means described herein, perfectly uniformly colored coatings are secured, regardless of ornamentation, either on plain or raised surfaces, large or small, bright or dull, which resist the influence of light. The articles, especially those of metal, bone or celluloid, are coated according to a well-known process, with a pure colorless varnish and are allowed to dry for half an hour at a temperature of 60° C., lower temperatures requiring longer time.

To color the objects thus prepared requires a solution of vegetable dyestuffs, of aniline colors or alizarine. Strong alcohol (ethyl, methyl or amyl) is needed for solvent. The articles first intensely heated are dipped into the color bath for a moment, either strung in order on a cord, or gathered together or placed in perforated tin vessels. Next, they are allowed to drip off to get rid of all liquid, and finally moderately dried.

The color baths must contain but ¼ to ⅓ per cent. of coloring substance, in order to produce handsome tints, whereas five times as much was required for the transparent varnish used formerly. This also affords the practical application of alizarine colors, which excel in resistance to light, but which could not be used for the coloring of metals, since they only possessed very little solubility.

A color bath of 100 grammes of alizarine in 100 liters of pure alcohol is needed to produce a bright yellow resistive color on copper which will be perfectly fast to light.

To secure a darker gold shade, a small amount of an alkali soluble in alcohol, 20 grammes per liter, is added to the color bath.

The requirements for the production of an even and handsome coloring are 1, the objects must be perfectly dry; 2, they must be well heated; 3, they must be carefully separated; and finally, 4, the color bath must contain no fat or oily substance. All attempts to produce colored varnish coatings by dipping failed, heretofore, because not sufficient notice of these four essentials was taken. The permanency to light of the shades obtained surpassed that of the best colored varnishes. As a result of employing alizarine colors on the objects, a smooth and glossy surface is produced that cannot be procured with the best colored varnishes. The greatest advantage of the new process lies in the fact that much time and labor are saved. In another patent referring to dyeing with alizarine colors, the following is still mentioned: the alizarine colors, which excel in great fastness to light, could not be used formerly for coloring metals, as they possessed but little solubility, and could not resist the discoloring action of the resinic acids contained in most varnishes. The process of immersion, however, produces colorings of too little brilliancy.

To obtain a reddish golden fast shade the following process should be employed: Dip the articles into a colorless varnish free from resinous acids, preferably a pyroxyline solution, and subject them to a temperature of 80° C. with brisk ventilation, so that the pyroxyline coating does not only dry superficially, but throughout. Next, place the dried and cooled objects into a solution of alizarine dyestuff. This solution is so composed that the articles require only an hour's immersion. Add, for instance, 2 grammes of an alizarine dyestuff to 1,000 grammes of high-strength alcohol. The objects, after the immersion in the dyestuff solution, are for a very short while dipped into cold water, and this bath changes the brown or yellow shade into a reddish golden one. After that the articles are freed from water by very sharp drying. The brilliant color of the coating and its fastness to sunlight are dependent upon the following conditions: 1, the colorless varnish employed must be perfectly free from resinic acids; 2, the articles must be dried, after the varnishing, with the aid of good ventilation; 3, the color bath must be free from water; 4, the gold color must develop by immersion in water.—L. Edgar Andée, in Neueste Erfindungen und Erfahrungen.

SELECTED FORMULÆ.

Silver Nitrate Test for Cottonseed Oil.—Investigations of Charabout and March (Bull. Soc. Chim. de Paris) throw some light on the value of this test in presence of olive oil. The free fat acids obtained from 50 grammes of cottonseed oil by saponification were treated in accordance with the method of Milliau on a water bath with a 3 per cent. solution of silver nitrate, and the brown precipitate thus formed, subjected to a chemical examination. It was found to consist chiefly of a brown silver salt composed of a fat acid melting at 52° and congealing at 49° to 50° C., and of sulphide of silver. Olive oil, which contains a sulphur compound of an analogous composition, is also capable of forming a more or less distinct precipitate of a dark-colored silver sulphide with nitrate of silver. It is important to bear this fact in mind when examining olive oil for cottonseed oil.—Apoth. Ztg.

Ginger Ale Extract.—

1. Jamaica ginger, course powder	4	ounces
Mace, powder	½	"
Canada snakeroot, coarse powder	60	grains
Oil of lemon	1	fl. drm.
Alcohol	12	fl. ounces
Water	4	"
Magnesium carbonate or purified talcum	1	av. ounce

Mix the first four ingredients, and make 16 fluid-ounces of tincture with the alcohol and water, by percolation. Dissolve the oil of lemon in a small quantity of alcohol, rub with magnesia or talcum, add gradually with constant trituration the tincture, and filter. The extract may be fortified by adding 4 av. ounces of powdered grains of paradise to the ginger, etc., of the above before extraction with alcohol and water.

2. Capsicum, course powder	8	ounces
Water	6	pints
Essence of ginger	8	fl. ounces
Diluted alcohol	7	"
Vanilla extract	2	"
Oil of lemon	20	drops
Caramel	1	fl. ounce

Boil the capsicum with water for three hours, occasionally replacing the water lost by evaporation, filter, concentrate the filtrate on a hot water bath to the consistency of a thin extract, add the remaining ingredients, and filter.

3. Jamaica ginger, ground	12	ounces
Lemon peel, fresh, cut fine	2	"
Capsicum, powder	1	"
Calcined magnesia	1	"
Alcohol, Water, of each	sufficient	

Extract the mixed ginger and capsicum by percolation so as to obtain 16 fluid ounces of water, set the mixture aside for 24 hours, shaking vigorously from time to time, then filter, and pass through the filter enough of a mixture of 2 volumes of alcohol and 1 of water to make the filtrate measure 32 fluid ounces. In the latter macerate the lemon peel for 7 days, and again filter.

Hardening Plaster of Paris.—Plaster of Paris may be caused to set more quickly if some alum be dissolved in the water used for rendering it plastic. If the gypsum is first moistened with a solution of alum and then again burned, the resulting compound sets very quickly and becomes as hard as marble. Borax may be similarly employed. In 1877 the Prussian Government awarded three prizes for inventions submitted at its invitation of processes for hardening plaster of Paris casts. The principle of all these consists in this, that the objects are to be treated with a solution of caustic baryta. But it has been found that no matter how deep this penetrates, the baryta is again drawn toward the surface when the water evaporates, a portion effloresing on the outside, and only a thin layer remaining in the outer shell, where it is converted into carbonate. This at the same time stops up the pores, rendering it impossible to repeat the operation. It was later found that the whole mass of the cast might be hardened by applying to it with a brush made of glass bristles, a hot solution of baryta. To prevent separation of the crystallized baryta at the surface, the object must be raised to a temperature of 60° to 80° C. To produce good results, however, it is necessary to add to the plaster before casting certain substances with which the baryta can combine. These are silicic acid in some form, or the sulphates of zinc, magnesium, copper, iron, aluminium, etc. With some of these the resulting object may be colored. As it is, however, difficult to insure the production of uniform tint, it is better when employing salts producing color, to mix the plaster with about five per cent. of quick lime, or, better, to render it plastic with milk of lime, and then to soak the object in a solution of metallic sulphate.

The Techno-Chemical Receipt Book gives the following directions for Brethauer's method of preparing plaster of Paris casts for resisting the action of the weather. Slake one part of finely pulverized lime to a paste, then mix gypsum with lime water and intimately mix both. From the compound thus prepared the figures are cast. When perfectly dry they are painted with hot linseed oil, repeating the operation several times, then with linseed oil varnish, and finally with white oil paint. Statues, etc., prepared in this way have been constantly exposed to the action of the weather for four years without suffering any change.

Jacobsen prepares casts which retain no dust, and can be washed with lukewarm soap water by immersing them or throwing upon them in a fine spray a hot solution of a soap prepared from stearic acid and soda lye in ten times its quantity by weight of hot water.

Shellhass recommends the coating of plaster of Paris casts with a compound of finely powdered mica and collodion prepared as follows: the mica rendered perfectly white by boiling with hydrochloric acid or calcining, is ground very fine, sifted and elutriated, and then mixed with dilute collodion to the consistency of oil paint, and applied with a soft brush. Casts coated in this way possess a silvery luster, have the advantage of being indifferent to sulphurous exhalations, and can be washed without injury.—Pharmaceutical Era.

TRADE SUGGESTIONS FROM UNITED STATES CONSULS.

German Sample Rooms in Sydney.—The German manufacturers have come to the conclusion that if they would continue to make progress in the future as they have done in the last twenty years in their export trade, they can no longer depend on the sample and display rooms in Berlin, Frankfort, Leipzig, Hamburg, and other large cities of the empire, says acting Consul J. F. Monaghan, of Chemnitz. They begin to feel the inroads which other nations are making in the German foreign markets. They believe—and here belief is based on practical knowledge—they must, to hold their trade, transplant their sample and display rooms from German cities to the countries in which they intend to do business.

The manufacturers of the Grand Duchy of Weimar, with the Grand Duke at their head, have taken up this question and are about to establish a sample room in Sydney, New South Wales. It is claimed by the men at the head of the movement that it is impossible for any one concern to carry on this undertaking alone; that different industries must combine and make the burden as light as possible. The Bavarian commercial and industrial chambers have made a close study of this enterprise and the opportunities offered in the Australian market, and have come to the conclusion that the best way to develop their industries is to join the Weimar manufacturers.

The exporters have found by close study that the principal wants of Australia are all kinds of machines, lamps, brushes, gloves, shoes, glassware (including optical goods), photographic supplies, musical instruments of all kinds, paints and oils, candles, agricultural machines and instruments, furniture of all kinds, and beers.

This is an opportunity that American manufacturers should not neglect. There is hardly an article named in the foregoing list that we cannot make as well as, if not better than, the Germans. There is no question but that in time we will force our way into that market, but it will be hard work after the Germans have gained possession, and we should try to get in first.

Electric Lighting in Greece.—In reply to an inquiry by the United States Export Association, of New York, Consul McGinley writes from Athens, December 2, 1899:

A company has recently been formed in Athens known as the Greek Electrical Company, with a capital of 5,000,000 drachmas (about $600,000, at present exchange). The founders are the Bank of Athens and the Société Générale d'Enterprise. The object of the new organization is to undertake the electric lighting of Athens, Piræus, Patras, Syra, and Kalamata. There are 50,000 shares, at 100 drachmas a share, but they are now selling at a premium, being quoted at 107 drachmas a share on the floor of the exchange of Athens. Bids can be addressed to the company direct or to G. A. Constantinides, 3 Corais Street, Athens. I have not been able to learn when the company expects to start operations.

German Bandage Trust.—Consul-General Guenther sends the following, dated Frankfort, December 16, 1899:

According to the German newspapers, there is hardly any branch of industry in Germany which has not been made the subject of a trust, in order to control prices and guard against the results of unrestricted competition. Recently, the German manufacturers of bandages met at Berlin to form an association. It was also proposed to establish a supervision of the production by medical officers of the government, so that complaints from physicians, dealers, and the public might be avoided.

Proposed Electrical Enterprise in Venice.—At the request of a New York export association (to which the letter has been forwarded), Consul Johnson sends from Venice, under date of December 19, 1899, copy of a memorandum from one of the engineers interested in the projected company for supplying electrical energy to Venice, as follows:

MEMORANDUM.

At the request of the Chamber of Commerce of Padua for information regarding the utilization of the waters of the River Cellina and part of the River Piave for the purpose of transferring electrical energy to Venice and vicinity, the following is submitted:

The Cellina, with an annual average capacity of 12 cubic meters (423·7 cubic feet) per second, and in two falls of the combined height of 100 meters (328 feet), is able to supply Venice with electrical power equivalent to 10,000 horse power at a distance of 95 kilometers (59 miles). The government is ready to grant the concession, and the work can be begun immediately.

The Piave offers more favorable conditions. From the Piave would be derived 15 cubic meters (529·7 cubic feet) per second; that is to say, one-third of its capacity in the dry season, which would serve to feed Lake Santa Croce at a level of 380 meters (1,246 feet) above the sea. This lake, which acts as a reservoir, contains 100,000,000 cubic meters (3,531,660,000 cubic feet) of water, of which 20,000,000 cubic meters (706,332,000 cubic feet) would always be at the disposal of the hydraulic motors. The falls in this system would be two, with a combined height of 225 meters (738 feet). It would be possible to include a third fall 70 meters (229·6 feet) high. The water of overflow would serve for the irrigation of the plain between the Piave and the Livenza. From the two falls of 225 meters (738 feet) to Venice, 70 kilometers (43 miles) distant, 27,000 horse power can be conducted. By making use of the third fall, this figure could be increased by 8,400 horse power.

The existence of Lake Santa Croce will enable the energy to be doubled—that is to say, make it 70,000 horse power—during the hours of work. Another distribution from the Piave will be provided during the night. Application has been made for the government concession, but the concession will not be obtained for at least a year.

A private company has been formed to carry on operations on both of these rivers and is now negotiating with various banking houses for the necessary capital. The names of the prime movers in the enterprise are as follows: Counts N. and A. Papadopoli, Venice; Commendatore Giuseppe da Zara, Padua; engineers, Ernesto Breda, Milani, and Colle, care of the above.

English capitalists have sent a representative to Venice to arrange, if possible, for the co-operation of English promoters of similar enterprises. It is not unlikely that their offers will be accepted, in consideration of the high standing of the firms represented.

Mining in the Yukon: Routes to Cape Nome.—The weather for the past month has been comparatively mild, the thermometer ranging from 15° above zero to 18° below, says Ronald Morrison, Vice-Consul at Dawson City. This exceptional mildness at this season of the year has interfered materially with the working of claims, causing many mines to suspend work on account of water coming in the shafts and drifts, and, unless colder weather comes soon, the output of gold will fall far short of the estimate, which for this season has been calculated at $25,000,000.

The board of trade has adopted a resolution petitioning the Canadian government to extend the telegraph line to Forty Mile, and intends to petition the United States government to carry the line to Eagle City, which will give a service from Skagway, Alaska, to Eagle City, Alaska. The benefits of this extension in regulating the movements of steamers and from a commercial standpoint would be very great.

The Cape Nome excitement continues unabated. Word recently received from Skagway is to the effect that many are making preparations to undertake the journey of 2,600 miles over the ice via Dawson. If all who are contemplating it make the trip this winter, there will be one continuous line of people from Bennett to St. Michaels.

The transportation companies here are fully alive to the possibilities of an early spring rush, as is evidenced by the presence along the water front of several steamers and barges having a combined carrying capacity of nearly three thousand passengers, which, for the first time in the history of the country, are wintering this far up the Yukon River.

It is now generally accepted that the route to Cape Nome via Dawson will bring the traveler to his destination fully four weeks earlier than by the sea route. This is based upon information given by sea captains versed in the condition of the ice in Bering Sea and along the coast between St. Michaels and Cape Nome. They assert that spring floods drive the ice out of the Yukon River and away from the shore lines as far north as Cape Nome a full month earlier than the pack ice in Bering Sea goes out. Another advantage is that those who so desire can get off at Nulato and take the Indian trail across the country to Cape Nome, which, though more difficult, saves over 100 miles.

Business in Dawson is very dull. Many restaurants and two hotels have been forced to close their doors for want of patronage.

Prices remain about the same, with apparently full lines of all staples.

Iron Companies in Russia.—Vice-Consul Monaghan writes from Chemnitz, December 16, 1899, that a stock company has just been formed in Irkutsk, Russia, with a capital of 1,000,000 rubles ($515,000), to develop the iron fields lying in the neighborhood. It is intended to produce cast and refined iron. A company has also been organized in St. Petersburg with a capital of 6,000,000 rubles ($3,090,000) to work iron mines in Siberia. A German mining engineer has been put at the head of the St. Petersburg company.

Railway Contract in French Africa.—Consul Skinner writes from Marseilles, January 6, 1900:

Announcement is made that on February 16, 1900, bids will be received for the construction of a railway between Konakry and the Niger, in French Africa. The work will be disposed of in two sections. Bidders upon the first must make a preliminary deposit as a guaranty of good faith, amounting to 20,000 francs ($3,860), and in case of an award, a final guaranty of 40,000 francs ($7,720). The second section will be intrusted to a bidder who must give a guaranty of 100,000 francs ($19,300); and all bidders upon this section must deposit 50,000 francs ($9,650). The facts and conditions may be learned at the Ministry of Colonies, 3e Direction, 2e bureau, Salle 196, Paris; at the Marseilles Chamber of Commerce, and in other cities in France. The bids will be received at the Salle des Seances of the Permanent Market Commission, 4bis rue Jean Nicot, Paris, February 16, at 3:30 p. m., and in Konakry at the Government Palace.

The Hamster in Belgium.—Under date of Liege, December 19, 1899, Consul Winslow transmits the following statement relative to the ravages of the hamster in Belgium:

The farmers of this and adjoining provinces are very seriously annoyed by the hamster (Cricetus frumentarius), a small rodent, a native of Europe. It is remarkable for having a pouch on each side of the jaw, which it uses to carry grain and such articles as it consumes. A few years ago, this little animal made its appearance in this province from Germany, and has since increased very rapidly. Families have been found with sixteen young. They destroy grain, such as wheat, barley, rye, oats, etc., as soon as it becomes ripe, by gathering the kernel and storing it in their homes, which are large holes in the ground. As much as 170 pounds of grain have been found in the home of one of these families, as well as a quantity of beets and other roots. An association of farmers has been organized at Fexhe-Slins, near this city, which pays 4 cents per head for dead hamsters, and the government pays the same price. In one precinct near this city, 300 hamsters were killed during the past year, for which the bounty was paid.

Manufacture of Battik.—Consul Hill, of Amsterdam, on December 7, 1899, says:

I have just received, in reply to a request, a letter from Messrs. John Th. Uiterwyk & Company, of The Hague, respecting the manufacture of battik. This is the only firm in the Occident that manufactures this Eastern product. Battik is made in the Dutch East Indies by the natives, who decorate their clothing with it. A piece of linen is taken and all kinds of designs are outlined upon it with a pencil. When the design is completed, the ornamental parts of the fabric are covered with a liquid which possesses the quality of stiffening after being applied. The parts not ornamented are dyed the color desired. After the entire fabric has been ornamented in this manner, it is boiled in hot water so as to take the hard stuff out of the battik. The dyed parts will then hold the dye and the battik is ready. The Hague people were the first to introduce battik into Europe. It is made on linen, silk, velvet, and leather, and is exported to all the principal cities of Europe. Orders have been received from the Government to decorate the Netherlands department at the exposition at Paris in battik.

Railway Supplies in France.—After correspondence and a conference with the director (chief of administration) of the Chemins de Fer de l'Etat, I have been assured that bids for railway supplies coming from American sources will receive serious consideration, says Consul George H. Jackson, of Rochelle.

From the Clauses et Conditions Générales pour l'Exécution des Fournitures des Chemins de Fer de l'Etat I quote the following extract:

"Article I.—General Rule.—All business proposed relative to the supply of materials necessary for the State railways, whether it be done by private contract or by open competition, is submitted in its every particular to the following rules:

"Article II.—Conditions to be fulfilled by persons wishing to submit bids.—No one is permitted to compete for award of contracts who is not capable of giving a guaranty for a faithful execution of contracts. To this end, each bidder is required to present a certificate, stating his ability, and to deposit a regularly negotiated bond, except as provided for in last paragraph of Article IV., which follows hereafter, and other exceptions allowed by laws, decrees, and rules now in force. Foreign bidders can be admitted to competition. Bidders whose establishments are outside of France (French territory) and foreign bidders will be admitted only when a bond supplied by a French bank has been accepted by the director."

This administration operates 1,758 miles of road.

I was also informed that inquiries coming through this consular office will receive attention.

Demand for Mandarin Oranges in Europe.—Under date of December 20, 1899, Consul Skinner, says:

American growers of oranges may be interested in knowing that a rapidly developing demand for mandarin oranges is noted throughout Europe. Fifty years ago this variety of orange, which had been introduced from China, was cultivated almost exclusively in Sicily and Malta, and sold at retail in Paris for from 7 to 10 cents for one orange. At present, the two islands named furnish none of the mandarins imported into France, and the sources of supply are Algeria and Spain. The trees are grown with some success even in France itself, as far north as Nice, but the quality is not equal to that of the Spanish and Algerian fruit. It is thought that the present demand will steadily increase, and French horticulturists are exceedingly anxious to see Tunis become an exporting point. In 1892, the imports into France of mandarins were as follows: From Spain, 1,617,673 kilogrammes (3,566,800 pounds); from Algeria, 428,018 kilogrammes (943,600 pounds); from all other countries, 209,853 kilogrammes (462,600 pounds). In 1898, the importations had increased to 2,029,946 kilogrammes (4,473,200 pounds) from Spain, 2,043,765 kilogrammes (4,529,900 pounds) from Algeria, and 181,023 kilogrammes (399,000 pounds) from all other countries. The American effort to procure a hardy tree as well as a delicious and salable fruit might advantageously include consideration of orange culture in this section of the world.

Land Tax in Kyao-chau.—Under date of Shanghai, November 19, 1899, Consul-General Goodnow transmits the following information, supplied by the acting British consul-general at that port, relative to taxation in Kyao-chau:

The German Government has adopted the system of single tax for Kyao-chau, levying a tax of 6 per cent on land values. Until the first of January, 1902, the value of land is represented by the sum paid to the Government at the land auction. After this term, a revision of the land values is purposed. Besides this tax, the owner has to give to the Government one-third of the net profit he realizes at a sale of his parcel of land. All improvements made on the estate, including an interest of 6 per cent., is deducted, according to the owner's statement, subject to official control. If a parcel of land does not change its proprietor by sale during twenty-five years, the Government is entitled to levy a tax of one-third of the surplus of value in analogy to the one-third taken at a sale. These proceedings may be repeated after another twenty-five years.

Custom House at Yao-Chou-Fu.—Minister Conger informed the Department, under date of Pekin, November 12, 1899, that, according to advices from the Tsungli Yamên, the custom house at the new port of Yao-Chou-Fu, in the province of Hunan, was to be opened November 13.

INDEX TO ADVANCE SHEETS OF CONSULAR REPORTS.

No. 646. February 5.—French Interests in the Transvaal—Wheat for Edible Pastes in France.—Iron in Santo Domingo—*Trade Conditions in Russia.

No. 647. February 6.—American Dredge in Russia—*Mining in the Yukon: Routes to Cape Nome—Conditions at Chefoo—Emission of Paper Money in Paraguay.

No. 648. February 7.—Demand for Coal in France—Cattle Fair in Uruguay—*Demand for Fish Scales in France—*French Wine Crop of 1899: Correction—*Consular Invoices Required by Brazil—*Disposal of Trade Catalogues at Vancouver.

No. 649. February 8.—Merchant Marine of Sweden—Inaccuracy in American Grain Inspection—Coal at Malta—*Proposed Electrical Enterprise in Venice—*Iron Competition in Russia—*Railway Contract in French Africa.

No. 650. February 9.—Tariff Changes in Martinique—Manchester Exports to the United States—Mutual Aid Societies for French School Children—*Canadian Butter in England—*Pictures Offered for Sale—*Change of Postal Rates in Paraguay.

No. 651. February 10.—Export of American Coal to Germany—Electrical Development in Canada—Horse Breeding in Belgium—*Unemployed Diamond Workers at Amsterdam—*Argentine Tariff for 1900.

The Reports marked with an asterisk (*) will be published in the SCIENTIFIC AMERICAN SUPPLEMENT. Interested parties can obtain the other Reports by application to Bureau of Foreign Commerce, Department of State, Washington, D. C., and we suggest immediate application before the supply is exhausted.

THE MAN'S KNIFE AMONG THE NORTH AMERICAN INDIANS—A STUDY IN THE COLLECTIONS OF THE UNITED STATES NATIONAL MUSEUMS.*

By OTIS TUFTON MASON, Curator, Division of Ethnology.

INTRODUCTION.

AMONG implements used by man, the same forms may sometimes be employed for destruction and at other times for industrial purposes. When used for destruction they are weapons, but when their function is industrial they are tools. The same object, when used as a weapon, becomes a dagger, but if it be employed as an edged tool it is a knife. As in the case of all other weapons or tools, the edged tools work by pressure, by friction, or by a blow. One used by means of a blow is an ax if the edge is in a line with the handle, and an adz if it lies across the handle; an edged tool working by friction is a scraper, but one working by pressure is a knife.

It will be found in the study of industrial knives that in the long run they become the carver's and engraver's tools, the drawing knife, the spokeshave, the plane, and the planing mill. In some styles of the last named, however, the operative part of the machine is, more properly speaking, a machine adz than a knife. Carving in wood and other substances by the American aborigines differentiated the adz from the knife. It is probable that before the introduction of iron into America the adz was used more than the knife in dressing down wood; but when the iron blade came into vogue it was possible for the savage workman to carve out hollow dishes and boxes, and other objects with his knife by simple pressure. Notable exceptions to this are those regions where soft wood came into alliance with shark's teeth and the incisors of rodents. This is shown in all the curved knives of the collections in the United States National Museum from the two hemispheres, especially those from wooded areas.

IMPROVEMENT THROUGH THE CURVED KNIFE.

There ought to be no doubt that in every case where the savage was fortunate enough to obtain the knife, his carving and whittling were better done. There is a marvelous difference between carving on the one hand, man's work chiefly, and basketry or pottery on the other, conservative woman's work. In no tribes were the two last-named arts bettered by contact with the higher race. The work was done with the hands almost wholly. The tools were of the simplest character. The harsh iron awl was not so good as the smooth pointed bone awl, of which hundreds have been found, and the pride in personal endeavor departed with the quenching of the tribal spirit. The potter's wheel, such as it was three centuries ago, was only a barrier to the unmechanical sex. Therefore, those who constantly assert that prejudice made it impossible for the savage to better himself in the adoption of the white man's devices catch only half a truth.

CLASSIFICATION.

In the class of cutting tools called knives, there are in the United States National Museum, collected among the North American Indians, two series. One has been called the "woman's knife;" the other, therefore, may now be denominated the "man's knife."†

Both of these series exist aboriginally in two subdivisions, the one containing no iron or evidences of the use of that metal, the other made partly of iron or with iron. In fact, there are four subdivisions of the term "industrial knife," namely, woman's knife, ancient; woman's knife, modern; man's knife, ancient; man's knife, modern.

The man's knife of the modern type exists in three varieties, to wit, the "curved knife," with bent blade, employed usually in whittling; a second variety, named "straight blade," with a short straight cutting part used in carving stone, antler, ivory, and other hard substances; and a third variety, usually with an old knife blade or piece of file well worn down for its working part, employed in the function of a burin for scratching or etching on hard surfaces. The three varieties necessarily merge into one another, so that there are no broad dividing lines. The curved knife may now be carefully examined as a contribution to studying the man's knife of ancient type.

PARTS OF THE CURVED KNIFE.

Each variety of man's curved knife, as of other primitive and modern mechanics' tools, consists of three elements or parts, differing among the several tribes and from place to place in materials and forms, though the blades furnished by Europeans are of the same general motive.

First, the whittling blade is usually of iron or steel, beveled on the upper side and plain on the under side, and more or less curved upward at the outer end. The blades of commerce are not greatly different in shape, but it will be seen that native ingenuity has been able to fashion blades from any piece of iron. Murdoch, speaking of Point Barrow, says that "the carver's knife is not always curved in the blade."‡

Those that are sold to the natives are mostly curved, and the handles are added afterward. Example Cat. No. 89,294 in the United States National Museum from Point Barrow has a short, thick "jackknife" blade much worn down. It is hafted between two longitudinal sections of reindeer antler held together by rivets, one section being cut out to receive the tang. Two rivets are of iron and three of brass.

The tang of the blade, which exists as an element in the hafting, is usually a continuation thereof, without much finish, being a flat rectangle in outline. The form of the tang, however, will be governed by the method of its application to the handle, as will appear. It may be, first, pointed and driven into the end of the handle; second, rectangular and laid between the halves of the handle; third, set into a narrow groove on top of the handle; fourth, laid in a shallow groove on the side of the handle; fifth, set in a saw-cut in the end of the handle.

Second, the handle or grip. This may be either of wood taken from the forest or from wreckage, or of bone or antler. The woman's knife, usually, has the grip attached to the back of the blade along its extent and the blade in position is under the grip. But in the man's knife the end of the blade forms the tang and the place of attachment for the handle, and therefore the grip is cylindrical or partly so. In point of fact the handle may be said to have three parts—the pommel or butt, quite frequently ornamented, even in tools of savages; the grip or portion actually in the hand, and the joint or hinge. The form of the grip may be that of the natural piece of material. Women's knife handles are much more delicately fashioned to fit the fingers than are those of the man's knife. But in the curved type the thumb is especially cared for, as giving leverage and guidance in whittling, and in some examples a long extension of the handle enables the whittler to call into activity every muscle of his forearm. The portion of the handle and the treatment of it with reference to the bond or connection with the blade will be spoken of in the next paragraph. The modifications of the handle for the insertion of the working part involve the selection of the grain, splitting one end, splitting the handle, drilling, grooving, sawing, socketing, etc.

Third, the bond or "connective" between the blade and the grip—that is, between the working part and the manual part. In the history of tools these connective devices have had an interesting elaboration. Practically, the bond between working part and manual part consists of three elements: First, a modification in the blade corresponding to the tang; second, a modification of the handle for the insertion of the tang; and third, the true connective of packing, cement, lashing, rivets, wedges or screws, some of which appear in the illustrations of this paper. Where the tang is driven into the end of the grip the elasticity or cohesion of the material forms the bond. In many examples the principle of the ratchet and of the dovetail exist in the shaping of the tang and its socket or in cutting notches on the tang.

Before the introduction of the Iron Age into North America there existed the same elements in the composition of a knife, to wit, a blade of tooth, or shell, or stone; a handle of antler, bone, or wood; and a connective of rawhide, sinew, yarn, or twine, of packing, of cement, and possibly of rivets made of wood, bone, ivory, or antler.

MODE OF CUTTING.

All primitive men's knives with single edge, so far as the national collections indicate, are made to cut toward the operator. Double-edged knives, however, cut both ways. Among the American examples all are for the right hand or for both hands. Lawson distinctly says that "when the Carolina Indians cut with a knife, the edge is toward them, whereas we always cut and whittle from us; nor did I ever see one of them left-handed."* The farrier, as will be seen, also cuts toward him, but by turning his hand under, in an awkward sort of way, occasionally cuts from him. Two curved knives in the United States National Museum from the Ainos of Northern Japan, constructed exactly after the manner of the American curved knives, are made to fit the left hand, but they were received from the same person. It will be perfectly plain to one who has sharpened a quill pen or lead pencil that, in the absence of spokeshaves and fine carver's tools, the Indian was compelled to cut toward his body.

SOURCE OF CURVED KNIFE.

This manner of working is, doubtless, a survival of old processes of hand work before the introduction of more modern tools. It may have been overlooked by the student of technology that it was not until recently that any care was bestowed upon fitting the handles of mechanics' tools to the hand itself. In the case of the woman's knife it will be found that the further away the Eskimo live from the white race the more simple the handle of the scraper, while in those areas where the contact has been most intimate the handle is more completely and perfectly made to conform to the right hand.

It is astonishing that until Perry's visit to Japan the handles of all Japanese tools were extremely simple. There are some specimens of bronze implements found in Europe in which the handle conforms to the right hand of the worker. It is reasonably certain, therefore, that the man's knife and the farrier's knife have come down from a remote past in their present simple form.

It is not disputed that among American Indians all of the iron-bladed knives for men are exotics, at least in the working part or blade. Ethnographers will notice also that in the acculturation of savages it is always the working part that they are willing to improve without prejudice. The manual part holds its own longer, and it will be seen that the grip and connective of men's knives are often "old school" while the blade is "new school."

An important question arises as to the date of introduction and the exact European source of some of the forms of blades. The only survival in the United States of the curved blade is in the farrier's knife, with which he pares the hoof of the horse prior to laying on the shoe.

After a diligent search among cutlers it is difficult to ascertain how long this form of knife has been in use among farriers, and what its precise relation is to the North American curved knife.

Murdoch draws attention to the fact that the Eskimo of Point Barrow call all knives savik, meaning also iron, the identical word used in Greenland for the

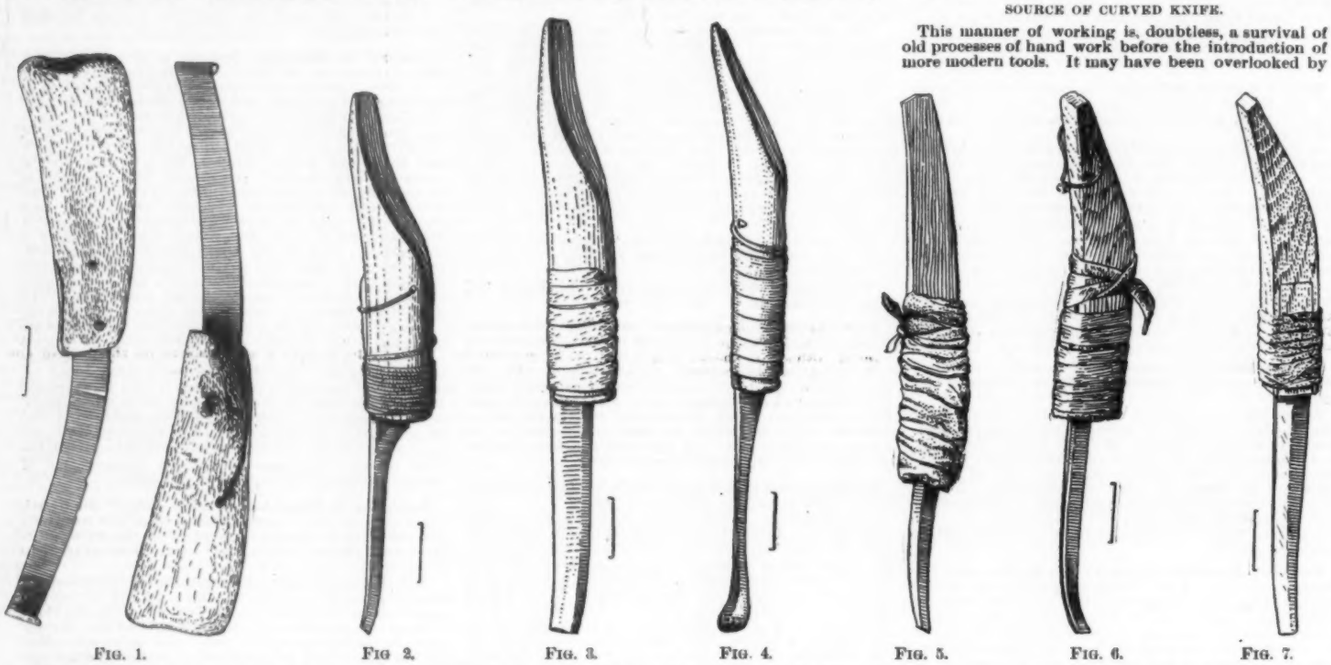


FIG. 1. FIG. 2. FIG. 3. FIG. 4. FIG. 5. FIG. 6. FIG. 7.

Fig. 1.—Farrier's Knife, back and front views, Washington, D. C. Figs. 2 and 3.—Micmac Curved Knives. Fig. 4.—Passamaquoddy Knife. Fig. 5.—Curved Knife from Ungava. Fig. 6.—Curved Knife from Montagnais Indians, Labrador. Fig. 7.—Curved Knife from Nascopi Indians.

* From the Report of the United States National Museums for 1897. Washington, 1899.

† The Uin, or Woman's Knife, report of the United States National Museum, 1890, pp. 411-416, plates 52-73.

‡ John Murdoch, Ninth Annual Report of the Bureau of Ethnology, p. 155, fig. 126.

* The History of Carolina, Preface, p. v, Raleigh, N. C., 1860 [reprint], p. 320.

same objects.* From this he argues that the first iron was obtained from the East, along with the soapstone lamps, instead of from Siberia, as was tobacco. It is true, however, that whittling with a curved knife having a thumb cavity prevails all over Eastern Asia. The white migrants to Greenland antedated those to Alaska, nevertheless, by several centuries. It will be found, also, by examining the Eskimo knives of Murdoch and Nelson, that they often differ radically from the Indian types here especially noted. Seldom does an Indian knife show the presence of the blacksmith, while the whaleship's blacksmith seems to have been a successful schoolmaster to the Eskimo. Moreover, ivory, antler, and bone are far less tractable than birch saplings for whittling, or cedar for shaping, excavating, or carving. The Eskimo blade is shorter, straighter, and never used with two hands, while the Indian knife is used for grooving and reducing large surfaces in the absence of the plane.

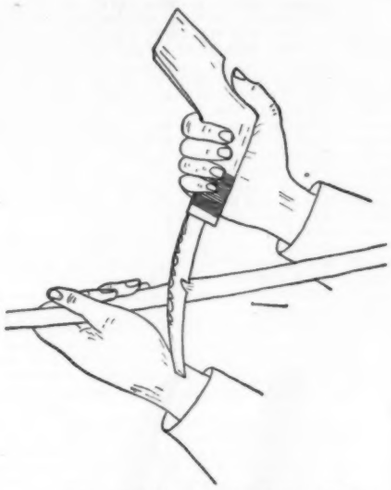


FIG. 8.—Eskimo Knife, Mackenzie River.

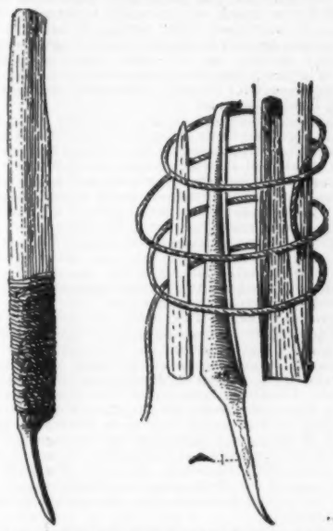


FIG. 9.—Two-handed Curved Knife, Showing Structure and Method of Using. Yakutat, Alaska.

Among North American aborigines the iron-bladed knife is restricted in its area to the Eskimo and the Indian tribes southward in Alaska, the Dominion of Canada, and the splint basket, snowshoe, the self-bow, and the birch-bark canoe area of the United States. The last-named implements are jackknives par excellence. They are designed for whittling and producing shavings, and not for chopping or scraping—that is, the formation of chips across the grain or of sawdust and scraps. These lines must not be too sharply drawn, however, inasmuch as this paper is restricted to materials furnished by the collections in Washington. It is wonderful how adept primitive artisans are in getting a variety of work out of one implement. In the absence of spokeshaves, planes, chisels, gouges, groove planes, small adzes, and a host of others, the Pacific Coast Indians do the work of all with a double-edged curved blade one-half inch wide and three inches long.

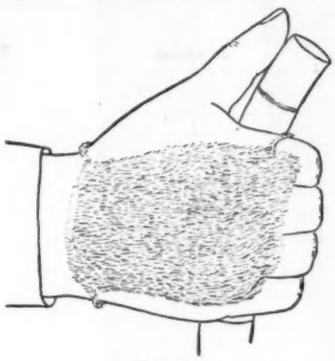


FIG. 10

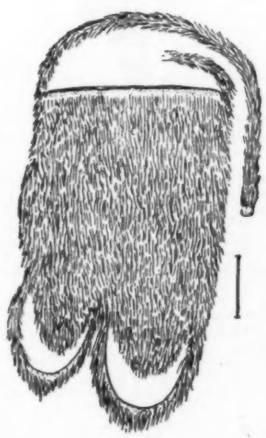


FIG. 11.

Carver's Knife and Guard for Back of Hand. Sitka, Alaska.

Within the regions mentioned there is for the student an excellent opportunity to study the effect, materials, and their environmental forces upon the construction of the knife. Two varieties of the man's knife are steadily used by the Eskimo—the carver's knife and the etching knife or burin; but, all other shapes are employed by them, so that one finds the curved knife for whittling, the straight blade for carving, and the pointed blade for etching. The blades are short and firmly attached to the handles by rivets or by lashing. The handles are usually of bone, antler, or ivory, some of them being curved to fit the forearm and give great purchase in cutting hard material; others are short and adapted to be grasped in the hand for the purpose of making small chips and even for scraping.

The Canadian Indians and those of the Northern United States, having only soft material and bark to work upon, restrict themselves mostly to the long-bladed curved knife. On the Pacific coast, among Indian tribes from Mount St. Elias and southward, there is a mixture of hard material and soft wood, so that there is a great variety in the form of the whittler's knife. Furthermore, these tribes have been in contact with sailors for more than a century and use any piece of steel or iron they can secure in trade. The Canadian Indians were stimulated by the fur-trading companies to travel more rapidly and to make longer journeys; hence, in furnishing them with the curved knife, they made it possible for these Indians to work out the frame of the birch-bark canoe, the bows of the snowshoes, splints for basketry, and a thousand and one objects made of birch bark, with this simple but most efficient device. It has become the traveling tool of the Canadian Indians and has done more than aught else to improve their mechanical skill. An examination of old patterns of snowshoes, in comparison with the latest patterns, reveals an astonishing improvement. The versatile curved knife is just as useful in the making of fine babiche or rawhide string for the webbing of the snowshoe as in whittling down the frame. In the old-fashioned snowshoes, the rawhide footing is nearly one-fourth inch wide, while in the best and latest, the strands are as fine as thread.

EXAMPLES.

Example Cat. No. 176,434, in the United States National Museum, is a farrier's knife (Fig. 1) made and used by M. E. Horigan, horseshoer in Washington, D. C. The blade is a wedge-shape piece of steel, flat on the lower side and beveled on the upper side, and bent to a hook at the other end. The tang is in form of a rectangle two inches long. The handle is a piece of a rib from an ox; the natural curve is taken advantage of in the manufacture; a slight notch is cut on the upper end for the thumb, and depressions have been worn on the upper face by the fingers of the operator. In order to combine the blade with the handle, a saw cut is made on the inner end of the latter for two inches. The tang is slipped into the saw-cut and is held firmly in place by two rivets passing through both it and the handle. Many thousands of specimens as rude as this are in use among the horseshoers all over the United States and Canada.

Example Cat. No. 153,603, in the United States National Museum, is a curved knife from the Micmac Indians of Nova Scotia (Fig. 2), collected by Dr. G. M. West. It has the usual farrier's blade let into a narrow notch or stub groove on the back of the handle and held by a seizing of cord. The handle of hard wood fits the hand of the workman very neatly.

In this example, as in others, the seizing or connective, holding the blade and the handle together, is easily removed so as to allow the former to be taken out and sharpened. Especial attention is called to the fact that, in accordance with northern usage, the end of this cord is driven into the handle and held fast by means of a wooden peg instead of being fastened off by being tucked under one of the former roundings itself. Length, 9¼ inches.

Example Cat. No. 153,604, in the United States National Museum, is a curved knife also from the Micmac Indians of Nova Scotia (Fig. 3), collected by Dr. G. M. West. The blade is of European manufacture, slightly curved, let into a groove on top of the handle and neatly seized with a thong of rawhide. At one end the thong is doubled over the tang and driven into the groove of the handle; the other end is drawn through a hole bored in the handle, wedged fast and cut off, making a very neat finish. The handle is made of birch wood and curved to fit the hand, the bevel for the thumb being unusually long and broad. Length, 10¼ inches.

The Micmacs are especially whittlers in bow staves, snowshoes, and canoe frames. The women also make splint baskets in wickerwork. Their household utensils were in wickerwork and birch bark, so they did little adzing.

Example Cat. No. 54,338, in the United States National Museum, is a curved knife from the Passamaquoddy Indians, Eastport, Me. (Fig. 4), collected by Mr. R. Edward Earll. The blade is in form of a farrier's knife, let into a stub groove on the back of the handle, and held in place by a seizing of wood splint. The handle is straight in the grip, and turned up and beveled at the outer end to receive and fit the thumb, as in other curved knives. The connective of wood splint is specially noteworthy in its neat administration and thoroughly aboriginal fastening off, as in the two previous specimens from the Micmac Indians. Length, 10½ inches.

Mr. Lucien Turner says of the Nenenot Indians of the Algonquian stock, living on the borders of the Ungava, in Northern Labrador, that "they make their crooked knives of steel files and knife blades (Fig. 5). The Indian reduces the metal to the shape desired, flat on one side and beveled on the other, by grinding. He then heats the blade and gives it the proper curve." He also draws attention to the fact that left-handed persons suit the tool to their hand by bending the blade in the proper direction. "No Labrador Indian ever goes on a journey without a curved knife. The handle is held at right angles to the body and drawn toward the user. It is employed in all cases for whittling or shaving wood and the preparation of the strips and slats of canoes, paddles, snowshoes, and everything cut from wood. It requires great skill to use the knife properly."

Turner says that "this tool is in universal use both among the Eskimo and the Indians of this region."

FIG. 12. FIG. 13. FIG. 14.

Fig. 12.—Carver's Knife for Two Hands, Sitka, Alaska.
Figs. 13, 14.—Carver's Knives, British Columbia.

Example Cat. No. 153,498, in the United States Na-

* John Murdoch, Ninth Annual Report of the Bureau of Ethnology, page 157.

tional Museum, is a curved knife from Labrador (Fig. 6), collected by Dr. H. G. Bryant. The blade is like that of the farrier's knife. The shank is let into a stub groove on the side of the handle; a thin portion of the piece of wood taken out is restored and a seizing of tawed buckskin is wrapped around. The handle is rectangular and terminated with a curved portion to fit the thumb. The noticeable feature of this knife is that the shank of the blade is let into the handle in such way that when cutting is being done the strain comes against the solid wood and not against the buckskin lashing, as in a great many examples studied. Whittling does not involve hard pressure, so there is no necessity for a strong joint, as in the knives for carving hard substances.

Example Cat. No. 153,046, in United States National Museum, is a curved knife from the Nascopi Indians of Labrador (Fig. 7), collected by Mr. Charles McLaren. The blade is inserted into a stub groove in the top of the handle, and this is covered by a strip of wood, and all lashed together with a rawhide band, which is fastened off by tucking under at both ends. The handle is of spruce wood, and the grip is straight, but the thumb portion is bent up and inward so as to fit exactly the curvature of the hand. A loop of string at the outer end of the handle completes the device. Especial attention is called to the neat fastening of the rawhide connective. Length, 9 inches.

In the annual report of the Bureau Ethnology, Dr. W. J. Hoffman figures a curved knife in general use among the Menomini Indians in Wisconsin. These Indians are of the Algonquian stock, and one is not surprised, therefore, to find a curved knife of the same type as those of Eastern Canada and the United States. The handle has a long slope for the thumb; the tang of the blade is set into a stub groove on the side of the handle and at the tip end carried quite through. The connective portion of the handle is also cut in a long groove to secure the cord used in lashing. The author says that "among the Menominis this knife is used in preparing the splints from elm logs, out of which baskets are made."

The cutting is always done toward the body. In the

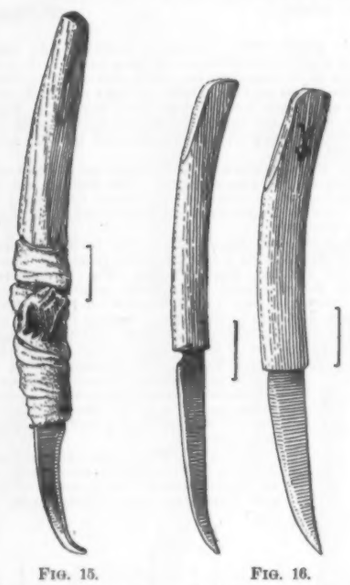


FIG. 15. FIG. 16.

Fig. 15.—Curved Knife, Fort Rupert Indians.
Fig. 16.—Carver's Knives, from the Ainos.

case of these knives it will be seen that the function of splitting, planing, and smoothing is performed rather than that of excavating and finishing off large blocks of soft wood.

The material employed by the Menominis in their basketry is tough, and therefore only soft saplings are used in their work.*

Holm figures a large number of men's carving knives.† Seven of his figures give bone or antler handles, four have plain wooden handles, and in two of them bone and wood are mixed. Seven of these have blades of stone and seven have iron blades. The preciousness of iron is shown in blades made up of two or three pieces or strips of iron riveted together. The blades are all inserted into the ends of the handles, most of them by driving. Two show evidences of saw-cuts at the ends and three have wrappings or bands of twine. The only ornamentation on these handles are rings and geometric figures made of dots. Four of the bone handles are shaped somewhat into characteristic forms.

Parry says that "the principal tool of the Eskimo of Iglulik was the knife (panna); that they possessed a great number of excellent ones previously to his coming, and that the work was remarkably coarse and clumsy. The manner of holding the knife also was most awkward; that is, with the edge backward."‡

Example Cat. No. 1,100, in the United States National Museum, is a curved knife from Anderson River in the Mackenzie River district (Fig. 8), collected by Mr. R. M. Macfarlane. The blade is much curved, let into a stub groove on the top of the handle, and held by a seizing of fine rawhide thong. One end of the thong is driven into the groove end of the handle, a favorite method of fastening off among the Eskimo. The other end is fastened off by simply drawing it through a dozen turns of the seizing. There are no knots tied. The handle is of fine spruce wood in the shape of a knee, and chamfered on the back to fit the thumb. This is an unusual shape among handles. Length of blade, 5 inches.

Murdoch declares that the Point Barrow Eskimo have two styles or sizes of carver's knives, one large Midlin, with a haft 10 to 20 inches long, for woodworking, and a small one, Savigron (instrument for shaving), with a haft 6 to 7 inches long, for working bone and ivory. The knife is held close to the blade between the index and second fingers of the right hand, with the thumb over the edge, which is toward the workman. Murdoch speaks in great praise of the skill of the carver.*

It is easy to understand the existence of the two types in the Arctic area, where soft driftwood exists alongside of antler and ivory.

Example Cat. No. 20,831, in the United States National Museum, is a curved knife from Prince of Wales Island, Alaska, collected by Mr. James G. Swan. The curved blade is of iron, with both edges alike, and resembles the modern can-opener. To form the joint its tang is roughly let into the wooden handle at its end on one side, the other side being notched, and is held in place by a lashing of thong. The handle of oak is curved upward outside the thumb space and tapers slightly to the outer end. The noteworthy features are the adaptation of a modern can-opener for the blade, the resemblance of the handle with its thumb space to Japanese and Korean handles, and the notch at the inner end to prevent the slipping of the seizing. Mr. D. W. Prentiss, Jr., of the United States National Museum, had the good fortune to observe a Yakutat Indian carving with a large specimen of this variety of

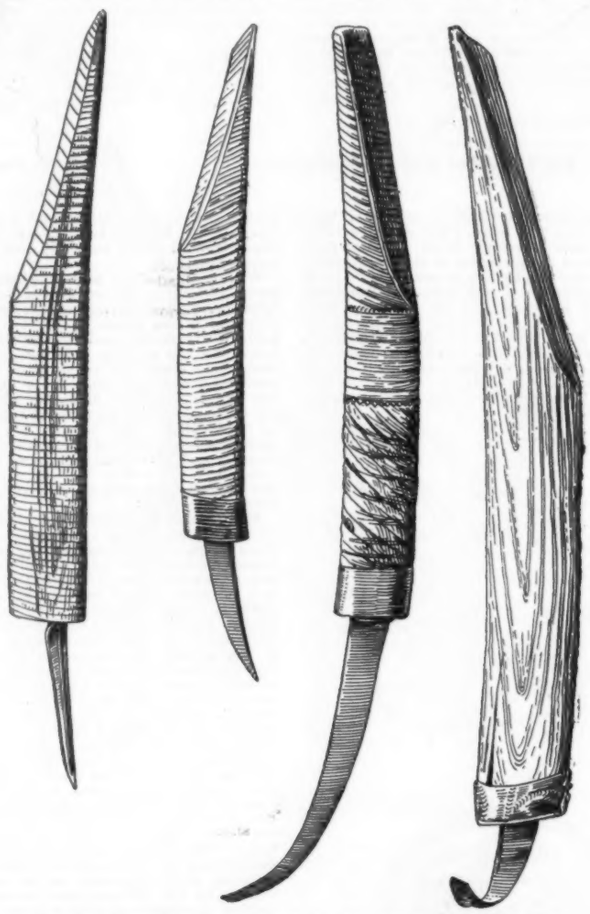


FIG. 17.—Curved Knives. Amoor Region. (After Von Schrenck.)

two-edged blade (Cat. No. 178,196, U. S. N. M.). The handle is held in both hands while the carver dresses down the inside of his canoe or wooden box. Now chipping toward himself, now away, with the greatest rapidity, he gave the fine adz finish often observed on many objects brought from the cedar areas of Southeast Alaska. In this its perfected form the knife is both chisel and adz, working always by pressure (Fig. 9).

Example Cat. No. 168,342, in the United States National Museum, is a curved knife from the Tlingit Indians of Alaska (Fig. 10), collected by Lieut. G. T. Emmons, U. S. N. It consists of a blade of a common pocket-knife driven into the end of a handle of antler and held in place by an iron ferrule and by a seizing of rawhide thong. The handle has rings scratched around it an inch apart. The example has this peculiarity, that the bevel of the blade is underneath, for the workman to cut toward him, and must have been designed, therefore, to be used after the modern fashion of a trimming chisel. Length, 7¼ inches. With this knife belongs example Cat. No. 168,345, United States National Museum, a guard of sealskin to be worn on the back of the hand (Fig. 11), so that when the workman is whittling in a box or canoe he may protect himself. The entire outfit is quite modern, but it is remarkable that this guard is the only example of its kind in the collection.

Example Cat. No. 20,752, in the United States National Museum, is a curved knife from Sitka, Alaska (Fig. 12), collected by Mr. James G. Swan. It is evidently made up for trade, and shows no sign of use, but it has the long handle of the Yakutat two-handed type. The blade, with two edges, is lashed by its tang to the side of a pine handle by means of a buckskin thong, which last is the only aboriginal part of the apparatus, and is laid on in a slovenly manner, and any savage would be ashamed to use it on his own account.

Since ethnographic material has entered into commerce the museum curator is vexed continually by receiving specimens that never had any serious aboriginal use. Furthermore, in trade centers, such as Unalaska, Sitka, Victoria, and Honolulu, where in the old days whalers met and exchanged or pawned their collections from different places, specimens were carried far from their original source, and now can be identified only by comparing them with well authenticated objects.

Example Cat. No. 129,976, in the United States National Museum, is a wood carver's knife from the Kwakiutl Indians of Fort Rupert, British Columbia (Fig. 13), collected by Mr. James G. Swan, and forms a transition between old art and European art. The blade is that of a modern jackknife set into the end of an oak handle and held firm by a ferrule of sheet brass nailed on. Here are united in a single joint the most primitive and most persistent connective, namely, a tang driven into the grain of the handle at the working end and metal ferrule, the latest form of bond. The handle is slightly curved, and bears on its end and surface a carving of a totemic animal's head and fins. Length, 8¼ inches.

Example Cat. No. 129,978, in the United States National Museum, is a similar knife, with jackknife blade, in a very plain handle without carving (Fig. 14). To form the joint the inner end of the handle has a saw-cut made across, into which the tang of the blade is set and made fast by a wire driven through the hinge hole. Stovepipe wire is wrapped about the joint, and a wedge of wood and one of iron driven in between the edges of the tang and the wire. Outside the wire is a wrapping of cotton rag to protect the hand. This example shows that there is plasticity even in the savage mind. The elements of this old form have been nearly all patented inventions.

Example Cat. No. 129,977, in the United States National Museum, is a curved knife of the Fort Rupert or Kwakiutl Indians (Fig. 15), collected by Mr. James G. Swan. It consists of a blade bent up at the top, beveled only on the upper side, and by its shank lashed to a shouldered cut on the handle. The handle is of oak and is also curved. The two parts are held together by a seizing of twine, and outside of this a wrapping of blue cloth. Length of handle, 8 inches.

Example Cat. No. 150,715, in the United States National Museum, is a curved knife of the Ainos of Yezo (Fig. 16), collected by Mr. R. Hitchcock. The tang of the blade of iron is driven into a wooden handle, which is slightly curved and has a chamfer for the thumb. There is no attempt at cementing or seizing or ratcheting on the tang. The bond is in effect a very ancient connective done in iron. Length, 7¼ inches.

Example Cat. No. 150,715 (a), in the United States National Museum, is similar to the foregoing excepting that the blade is straight and there is a slight carving at the outer end of the handle. The handle in both

* Fourteenth Annual Report of the Bureau of Ethnology, p. 280; also Harper's Magazine, March, 1894, p. 506.

† Holm, Ethnologisk Skizze, Copenhagen, 1887, plate 18.

‡ Parry's Second Voyage, London, 1824, p. 536.

* Ninth Annual Report of the Bureau of Ethnology, p. 157, Fig. 118.

of these specimens seems to be left hand, inasmuch as the bevel and curve of the blade and the chamfer fit the left hand and do not fit the right. The great number of whittling knives of this species in eastern Asia raises some interesting questions of the method of intrusion of the Iron Age into the aboriginal life of the Western World.

In the area between Bering Strait and the Aleutian Islands, under the influence of Russian traders and the whaling industry, great numbers of carvers' knives in endless variety are found. The largest collection from this region has been made by Mr. E. W. Nelson, and the forms of whittling knives, carving knives, and etching knives will be found fully illustrated in Mr. Nelson's work.

A large and interesting series of curved knives were collected by Von Schrenck about the mouth of the Amoor River and northward, and are now in the Imperial Museum at Moscow. These knives represent all of the different classes spoken of in this paper, to wit: Knives with straight blades, for ordinary domestic purposes; those with long curve, for ordinary whittling; those with abrupt curve at the end, as in the farrier's knife, for excavating canoes and boxes; and those with sharp points, for engraving on hard substances. The handles are either plain or ornamented and have a short or a long bevel for the thumb. Those which have a decided sidewise curve are always fitted to the right hand and cut toward the person (Fig. 17).

CONCLUSION.

I find that in the employment of the curved knife the Eskimo, the Canadian tribes, together with their kindred on the northern boundary of the United States, and, more than all, the North Pacific tribes on both sides of the ocean, have exhausted the possibilities of an implement that has been in the hands of some only a century or two.

The arts of all these tribes were bettered and not degraded by the curved knife. In every case they were immensely improved. The form of knife with straight, short blade made it possible for the northern and western tribes to become better carvers and engravers. Before the possession of iron there is meager evidence that either of these areas possessed other than the most trivial carvings in hard material. Their best results were in soft wood and slate, by means of beaver tooth or shark's tooth knives.

The curved knife serves to confirm the opinion that as soon as any process or device came within the scope of a people's intelligence they have mastered it and brought it to a climax, from which time on new ideas and new inventions replaced the old.

[Continued from SUPPLEMENT, No. 1259, page 20188.]

CRUISE OF THE "ALBATROSS."

THE following letter from Dr. Agassiz, dated Papeete Harbor, Tahiti Island, November 6, 1899, has been received by the United States Fish Commission and is here published by courtesy of Commissioner Bowers:

During our stay in Papeete some time was spent in examining that part of the barrier reef of Tahiti which had been surveyed by the "Challenger." We found the condition of the outer slope of the reef quite different from its description as given in the "Challenger" narrative. The growing corals were comparatively few in number, and the outer slope showed nothing but a mass of dead corals and dead coral bowlders beyond 16 or 17 fathoms, few living corals being observed beyond 10 to 12 fathoms.

We also made an expedition to Point Venus, to determine, if possible, the rate of growth of the corals on Dolphin Bank from the marks which had been placed on Point Venus by Wilkes, in 1839, and by MM. Le Clerk and De Bénazé, of the French navy, in 1869. We found the stones and marks as described, but, in view of the nature and condition of Dolphin Bank, did not think it worth while to make a careful survey, as Captain Moser had intended to do. On examining Dolphin Bank in the steam launch, I was greatly surprised to find that there were but few corals growing on it. I could see nothing but sparsely scattered heads, none larger than my fist, the top of the bank being entirely covered by nullipores. We sounded across the bank in all possible directions and examined it thoroughly, and at the stage of water at which we sounded, found about 18 inches difference from the soundings indicated by the charts. It is also greatly to be regretted that Dolphin Bank was not examined, neither in 1839 nor in 1869, and notes made of what species of corals, if any, were growing on its surface; for an excellent opportunity has been lost to determine the growth of corals during a period of 60 years. The choice of this bank as a standard to determine the growth of corals was unfortunate, as it is in the midst of an area comparatively free from corals.

Extensive collections have been made at Papeete during our visit by the naturalists of the "Albatross."

After refitting and coaling here, we left on the 5th of October for a cruise in the Paumotus.

We steamed for Makatea, which we had visited on our way to Tahiti, and not only examined the island more in detail, but took a number of photographs of the cliffs on the east side, which, on our first trip, we passed late in the afternoon. We crossed the island from west to east, the path leading down from the summit of the cliffs bordering the island into a sink at least 40 to 50 feet lower than the rim of either face of the island. The sink occupies a little more than one-third the length of the island. It is deeper at its southern extremity, where it is said to be 75 to 100 feet below the rim of the adjoining cliffs.

It is difficult to determine if this sink is the remnant of the former lagoon of the island, or of a sound formed during its elevation; or if it has been formed by the action of rain and atmospheric agencies. The amount of denudation and erosion to which this island has been subjected is very great, as is clearly indicated by the small cañons, pinnacles, and walls of limestone, as well as by the crevasses which occur in the surface of the basin in all directions. The extent to which this action has penetrated into the mass of the island is also plainly shown by the great number of caverns which crop out at all levels along the sea face of the cliffs, some of which are of great height, and extend as long galleries into the interior of the island. It is, of course, difficult, in the face of this extensive denudation and erosion, to state positively what may be part of the ancient lagoon, or sound, and what has been carried away by atmospheric and other agencies since the elevation of the island. At the south end of the island, which is lower than the northern part, there are only two distinct terraces, while at the northern end four terraces can be traced. The southern extremity, however, is still higher than the deepest part of the central sink of the island.

From Makatea, we visited Niau, Apataki, Tikei, Fakarava, Anaa, Tahanea, Raroia, Takume, Makemo, Tekokota, Hikueru, Marokau, Hao, Aki-Aki, Nukutavake, going as far east as Pinaki, when we turned westward again to Nukutipipi.

On arriving at Pinaki we decided to give up the exploration of the eastern extremity of the Paumotus, and not to make our contemplated visit to the Gambier Islands, our time having been greatly curtailed by delays at Fakarava and Makemo, from bad weather, and the non-arrival of our coal supply. We therefore reluctantly turned westward again and made for the Gloucester Islands. These, as well as Hereheretue, proved most interesting; they formed, as it were, an epitome of what we had seen on a gigantic scale in the larger atolls of the western and central Paumotus. We could see at a glance in such small atolls as Nukutipipi and Anu-Anurunga, the connection between structural features which, in an atoll 40 miles in length and from 10 to 15 miles in width, it was often difficult to determine.

Except at Nukutavake we found no village in which the habits of the natives had not been more or less modified by civilization. The Paumotu Islanders have practically given up building their own houses; they use European models, and their roofs are composed in great part of galvanized iron. There are also but few of the original native canoes to be seen. In a few years all traces of their customs and crafts will have disappeared.

We also steamed by Kauehi, Tænga, and Tuanaka. We anchored in Fakarava and Makemo lagoons, spending a number of days in both these atolls. We usually timed our visits to the islands where we could not anchor so as to spend the day, or the greater part of the day, at these atolls, making our passages at night and sounding whenever practicable on the way.

After leaving Tahiti, we made over 100 soundings. These have shown in a general way that the western islands are probably all on a great plateau connected perhaps by the 900-fathom line; that such islands as Anaa are probably on spurs or independent smaller plateaux, separated from the main plateau by somewhat deeper water. The same may be the condition of Raroia and Takume, and of Hao and Amanu, while such smaller and isolated peaks as Tikei, Aki-Aki, Nukutavake, and Pinaki, as well as the Gloucester Islands, rise from greater depths and are isolated peaks. At any rate, these soundings indicate, as do the soundings off the Fijis, that atolls do not necessarily rise from very great depths, and that in this characteristic atoll district, atolls are found, it is true, with steep slopes, but rising from moderate depths. The slopes of these atolls would probably resemble in every respect the slope of the elevated coralliferous limestone islands characteristic of the Lau Group in Fiji.

The deepest sounding among the Paumotus was on the line to the northward of Hereheretue in the direction of Mahetia, where we found a depth of 2,524 fathoms, and a continuation of the red clay characterizing the soundings since we left Pinaki. In nearly all the soundings among the Paumotus, even at moderate depths not far from the atolls, we brought up manganese particles or small manganese nodules. The last haul, made in deep water on the way from Hereheretue, in 2,440 fathoms, brought up at least half a ton of manganese nodules, the bottom being red clay.

We have now steamed about 2,500 miles among the Paumotus, and although we had not the advantage of the accurate surveys of the English hydrographic charts, which made the exploration of Fiji so easy, yet from the structure of these atolls it was a comparatively simple task, by steaming around the islands and landing wherever practicable, to get a fairly good idea of their structure. We have seen nothing in this more extended examination of the group tending to show that there has anywhere been subsidence. On the contrary, the condition of the islands of the Paumotus cannot, it seems to me, be explained on any other theory except that they have been formed in an area of elevation; an area of elevation extending from Matahiva on the west to Pinaki in the east, and from the Gloucester Islands on the south to Tikei in the north, although the islands in the line of Mangareva to Tahiti are separated from the other Paumotus by a deep channel, nearly 200 miles wide and more than 2,400 fathoms in depth, with scattered islets and atolls extending from Mangareva to Pinaki, and northward to Serle Island and beyond, islands which are not connected with the extensive plateau upon which the greater number of the Paumotu Islands to the westward of Hao rise.

All the islands we have examined are, without exception formed of tertiary coralliferous limestone which has been elevated to a greater or less extent above the level of the sea, and then planed down by atmospheric agencies and submarine erosion, the greatest elevation being at Makatea (about 230 feet), and at Niau, where the tertiary coralliferous limestone does not rise to a greater height than 20 feet. At Rairoa it was 15 to 16 feet high. At other islands it could be traced only as forming the shore platform, from 50 to 150 feet wide, which forms the outer face of the Paumotus, and is so characteristic a feature of the atolls of the group. In other parts the old ledge could be traced cropping up in the interior of the outer rim, or in the open cuts connecting the lagoon with the outer sea face of the atolls. Everywhere the space between the outcropping of the old ledge, as I will call the tertiary coralliferous limestone, was filled with beach rock, or a pudding stone, or with a breccia or conglomerate of coralliferous material consisting in part of fragments of the old ledge and of fragments of recent corals and shells cemented together.

The appearance of the old ledge and of the modern reef rock is so strikingly different that it is very simple to distinguish the two, even when only comparatively small fragments are found.

We did not find in the Paumotus, as in Fiji, all possible stages of denudation and of submarine erosion between islands like Vatu Vara, Niau, Kambara, Fulanga, Ongea, Oneata, Ngele Levu, and Weilangilala, and atolls with a mere ring or surf to indicate their existence.

In the Paumotus the islands have been elevated to a very moderate height and probably to nearly the same height, for the old ledge forming the base of the modern structure is found exposed nearly everywhere at about low water when it cannot be traced at a slightly greater elevation. This would readily account for the nearly uniform height of the islands throughout the group.

But there is another element which comes into play in this group, and has an important part in shaping the ultimate condition of these atolls. At the Fijis we have seen the submarine erosion continue until there is little left of many of the atolls beyond the merest small islet or rock to indicate its structure. In the Paumotus, in the great atolls which are evidently only the exposed summits of parts of ridges or spurs of an extensive tertiary coralliferous limestone bed, the rim of the atoll is, after having been denuded to the level of the sea, again built up from the material of its two faces which is thrown upon the wide reef flats both from the sea face and from the lagoon side. We do not find in the Fijis such huge reef shelves to supply such masses of material from the breaking up of the outer and inner edges of the tertiary limestone platforms, in addition to the fragments of recent corals growing upon the flat and its edges, which, when dead, are thrown up and formed into shingle and sand to form a pudding stone, or a conglomerate, or breccia, with the fragments of the old ledge on the top of the reef flats.

This pudding stone, or beach rock, is found on all the reef flats of the islands of the group. It forms great bars; at right angles usually to the shore line, and upon the sea-face of these bars is thrown up coral shingle, both old and recent, which builds up short reaches of beaches separated by wide flats through which the sea rushes at high water, or merely covers the flats at low tide; while on the lagoon side of the wide reef flats a similar process is going on, throwing up finer sand among the beach-rock bars and along their sides, and thus building up, little by little, at first small sand bars, then larger bars, or islets, at right angles to the shore-line; and as they become larger by accretions from both sides, they finally form an island from 1,000 to 1,200 feet long, according to the width of the reef flat, extending from the lagoon edge of the flat to the sea face of the atoll. The sand bars, little by little, become covered with vegetation, and at some stages of tide appear like islands and islets situated a considerable distance within the lagoon. Whenever the material supplied both from the lagoon side and from the sea-face is very abundant, the land ring becomes more or less solid, the islets become consolidated into islands, separated by narrow or wider cuts, until finally they form the larger islands which seem at first glance to form continuous land along the rim of the lagoon, but which are often seen to be separated according to local conditions by narrow cuts, which finally allow no water to pass through and merely indicate the former separation of the various parts of the land.

In the lagoons of atolls of such great length as some of these of the Paumotus, like Rairoa, Fakarava, Makemo and Hao, which are between 30 and 40 miles long, and others of less dimensions, considerable sea rises under the prevailing trades. The sea and wind generally follow the trend of the shores, both in the lagoon and along the sea-face, so that the bars of beach rock act like buttresses and collect material at their inner and outer extremities, forming the sand bars and islets which eventually become the land rim of the lagoon. When the material is not from local causes very abundant or is washed out over the flats, there are fewer islands, and often these are but mere islets or bars for long reaches of the shore, forming the characteristic weather faces of many of the lagoons.

Many of the lagoons are filled with shoals or ledges awash or a few feet above the sea-level. These shoals are parts of the old ledge which have not as yet been eroded, and the disintegration of which has gone far to supply material for the land of the outer rims of the atolls. In Fakarava there were no less than 36 islands and islets and ledges, parts of a former great flat, now broken up, existing parallel to the outer reef flat about four miles in the lagoon. Similar reef flats exist in Tahanea, where they form a secondary lagoon with two to three fathoms of water extending nearly the whole length of the western face of the atoll. There are several large islands on this flat, and at high water they would appear as the islands and islets of Fakarava do, as disconnected and planted in the lagoon itself. A secondary lagoon also exists in Ravahere and Anaa: in both these atolls the reef flat extends across one extremity of the lagoon and does not run parallel to the longer shore line of the atoll.

The lagoons of these atolls have a general depth of 13 to 20 fathoms. In some cases they are, as is stated, somewhat deeper (but there are no measurements), the greater depths being 30 fathoms or more, being due to orogenic conditions. Some of the atolls are quite shallow, as at Matahiva as well as Pinaki, where the lagoon is not more than two to three fathoms, and Takume, where it is from five to six fathoms deep. Some of the smaller islets we visited, among which are Tekei, Aki-Aki and Nukutavake, have no lagoons. The former has a shallow sink in which fresh water collects, but the rim is only very slightly higher than the interior. The last two islets are apparently depressed in the center, three to four feet below the outer bank of sand which forms the rim (about 10 to 12 feet high) of the basin of the island. I was at first inclined to look upon these islands as examples of islands which had been cut down to the level of the sea and subsequently been built up by beach rock and sand in the manner described above. The existence of extensive sand dunes on two sides of the island at Pinaki, and of a large dune (estimated to be 35 feet high) on the south shore of Nukutavake, seems to indicate the possibility of there having been a shallow lagoon occupying the center of Aki-Aki, and of Nukutavake, and that these lagoons were gradually filled by the sand dunes, much as Pinaki is filling now.

At Pinaki (Whitsunday Island), there is no doubt but that the lagoon is rapidly filling from the sand blown in by the dunes. They are from 12 to 15 feet high and are forcing their way in toward the lagoon,

killing the pandanus and whatever vegetation there is growing on the land rim of the lagoon. The dunes have probably filled also a second entrance to the lagoon, indicated now only by a somewhat lower level of the land rim. Mr. Moore and Mr. Townsend, who went ashore at Pinaki, report that the lagoon is not more than three fathoms deep; they could wade over the greater part of it. Mr. Alexander counted no less than 116 islets in this small lagoon—less than a mile in diameter—islets formed of masses of dead Tridacna shells thrown up on ledge rock, on the slopes of which grew madrepores. The bottom of the lagoon is covered by Tridacna and masses of a species of Area live near the edge, the intervening spaces being filled with nullipores. The entrance to the lagoon is perhaps 150 feet wide, and there is a cut through the beach rock covering the old ledge, giving access to the sea into the lagoon at certain stages of the tide. The water in the lagoon is quite warm.

At Pinaki, as at other atolls and islets to the eastward, there are fewer cocoanuts than on the westward atolls, and the vegetation consists in great part of pandanus and puteau trees and the usual coral reef vegetation of the Paumotus and Fijis.

The only atoll we have seen, the lagoon of which is entirely shut off from the sea, is Niau. In this case the old ledge forming the rim of the land, which surrounds the nearly circular lagoon, is about a third of a mile in width, and sufficiently high, 15 to 20 feet, to prevent any sea from having access to it except in case of a cyclone, as that of 1878, when the sea washed into the lagoon. The lagoon is shallow, of an average depth of about three fathoms, the deeper parts perhaps five. The water is brackish, of a density of 1·0216 at 28° C. There are no corals living in it, but a species of mullet is found, as well as many marine shells, which, like those in the lagoons of San Salvador, in the Bahamas, are of diminutive size compared to their representatives living outside. The floor of the lagoon is covered with algæ. The lagoon has probably a slight connection with the sea, the water percolating through the limestone ring separating it from the outer reef flat. It is very difficult in this case to decide whether this lagoon has been gradually filled up after elevation or whether it is merely a sink on a more or less uneven limestone surface.

Dana and the other writers on coral reefs mention a great number of lagoons as being absolutely shut off from the sea. I take it these statements are due to their descriptions being taken from charts, many of which (as in the case of the Paumotus) are very defective. For nothing is easier than to pass at a short distance by the wide and narrow cuts which give in so many places the freest access to the sea to the interior of the lagoons, and described as closed because they have no boat passages. I could mention as instances of such lagoons those of the atolls of Takume, Hikueru, Anaa, etc., which may be said to be closed, yet into which a huge volume of water is poured at every tide over low parts of the encircling reef flats.

The character of the coral reefs of the Paumotus is very different from that of other coral reef regions I have seen. Nowhere have I seen such a small number of genera, so many small species, and such stunted development of the corals. None of the great heads of the genera so characteristic of the West Indian regions, or of the great barrier reef of Australia, are to be seen; with the exception of a couple of species of alcyonaria they are absent, so far as our experience shows, and there are but few sponges and gorgonians to be found among the corals. The bathymetrical limit of the reef-building corals seems to be about 20 to 22 fathoms, but nowhere have I seen such extraordinary development of incrusting nullipores as on the sea edge of the shore platforms of some of the Paumotu atolls, where they build up to a height often four feet to form the outer edge of the secondary barrier reef so frequently seen along the reef faces of the Paumotus.

On the 4th of November we were well on our way to Mehitia, the easternmost of the Society Islands, the account of which will be included in my next letter, giving the results of our examination of the Society Islands.

We have taken a large number of photographs to illustrate the structure and mode of formation of the Paumotu atolls. Mr. Mayer has devoted much time to the drawing of the Medusæ collected.

Judging from the temperature taken at various points, 40° F. seems to be found quite generally at about 500 fathoms depth.

We made a number of surface hauls, as well as intermediate hauls, with the townets, but obtained very little animal life. The poverty of the surface pelagic life, and down to 300 fathoms, is remarkable. I do not think I have ever sailed over so extensive an area as that of the Paumotus and observed so little surface life; on calm days, under the most favorable conditions, nothing could be seen with the naked eye, and at night there was little or no phosphorescence. Inside the lagoons our hauls were equally barren.

The same paucity of animal life seemed to extend to the deep-water fauna. All the hauls we made off the islands, in from 600 to 1,000 fathoms, usually the most productive area of a sea slope, brought nothing, or so little that we came to grudge the time spent in trawling on the bottom, as well as towing on the surface or near it—a great contrast to the conditions of the Atlantic in similar latitudes, and very different from our anticipations. For these reasons no attempt has thus far been made to make a trial of the deep-sea pump while in such unproductive areas, and unfortunately while we were in the region of the equatorial current the weather conditions were not suited for a trial of the apparatus.

We expect now to coal and refit, and to leave for Suva via Tonga on the 15th of this month.

A. AGASSIZ.

In Russia the leaves of Epilobium angustifolium are largely used as a substitute for Chinese tea under the name of "Kaporie tea," the manufacture of which gives rise to a considerable industry in certain localities. The leaves of Epilobium hirsutum are also employed for the same purpose. The leaves of Vaccinium arctostaphylos, and sometimes of A. myrtillus, are similarly employed in the production of "Caucasus tea" or "The du Kutais." Both these fictitious teas and the genuine article are the subject of an exhaustive histological note by E. Collin in Journ. de Pharm.

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